THE FRESH-WATER FISHES OF NORTH BORNEO

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INTRODUCTION

Knowledge of the fresh-water fishes of Borneo, as well as of the entire East Indies, begins with the work of Pieter Bleeker. In a series of papers appearing during the period 1851–60, mostly in *Natuurkundig Tijdschrift voor Nederlandsch-Indië*, Bleeker recorded most of the fresh-water fishes now known from Borneo. When Vaillant summarized the fauna in 1893, fully 111 of the 152 primary fresh-water species[1] he listed had been reported by Bleeker.

All of Bleeker's fishes came from Indonesian (then Dutch) Borneo. Except for the description of *Gastromyzon borneensis* by Günther (1874), Vaillant's paper is the first to cite North Bornean localities for primary fresh-water fishes; he listed five from Mount Kina Balu. Subsequently, papers by Boulenger (1894, 1899), Regan (1906), Seale (1910), Hora (1932), de Beaufort (1933), Herre (1933, 1940a, 1940b), Fowler (1941), and Brittan (1954) have been devoted wholly or in part to the North Bornean fauna. However, none is concerned with the fauna as a whole. North Borneo comprises 29,387 square miles (or about one-tenth of Borneo's total of 286,969 square miles), yet its largely unreported fauna includes more than one-third of the primary fresh-water fishes now known from Borneo.

In their great faunal work on Indo-Australian fishes, Weber and de Beaufort (1913–22) discussed most of the species included in our paper, but they did not associate counts and measurements with fishes from specific areas, with the result that those data are not satisfactory for studies of geographic variation. We shall record the fishes now known from North Borneo, basing those records primarily on much larger collections than have previously been available and presenting basic information on these species in such a way that the data can be used by future reviewers of the various groups.

[1] This term, as used by Myers (1949), includes in North Borneo the groups Ostariophysi (exclusive of the Plotosidae and Ariidae), Anabantoidea, Ophicephalidae, and Mastacembelidae.

FIG. 1. Map of North Borneo.
In shaded areas altitude more than 1000 meters.

FIG. 1 (*continued*). Map of North Borneo.

Fluctuation of sea level during the Pleistocene glaciations alternately made and broke land connections among the present land masses of Malaya, Sumatra, Java, and Borneo (Molengraaff and Weber, 1921). During periods of the lowered sea level the major portion of Borneo was connected with the other land masses by shared drainage systems, but a large part of what is now North Borneo did not participate in these connections. This partial isolation gives the fish fauna of North Borneo great complexity and interest. Our data help in the analysis of the effects of that isolation.

The work of Weber and de Beaufort (op. cit.) and the more recent generic and family revisions by Brittan (op. cit.) and Sufi (1956) do not provide a picture of the fauna of individual small streams draining the rain forest that covers most of Borneo. The collections on which this report is based were made in such a way that they contribute to an understanding of the rain forest community. One of the purposes of this report is to present this sort of ecological information, which is not readily available for the oriental tropics.

Finally, our study has several functions that are not directly scientific. One is to provide the Colony of North Borneo with at least the nucleus of a catalogue of its fishes with the hope that it will be of use in the development of the fisheries. A second is to provide a handbook for non-specialists, whether interested residents or visiting biologists. With these non-academic functions in mind, local names actually in use have been given. The keys have been made as simple as possible and cover only those species definitely recorded from the fresh waters of North Borneo. As the fauna is still incompletely known, this limitation of the keys may cause some trouble. Explanation of fin ray and scale count notations is more lengthy than usual for the benefit of the non-ichthyologist.

Many species belonging to essentially marine groups undoubtedly enter fresh water in the larger rivers. Among these are various percoids, ariid catfishes, clupeoids, gobioids, hemiramphs, and tetraodonts. Only those for which positive fresh-water records in North Borneo are available have been included. The great bulk of the fauna, however, is made up of primary fresh-water groups.

Materials and Methods

This report is based primarily on the collections made by the Borneo Zoological Expeditions, 1950 and 1956, of Chicago Natural

History Museum, and by the Fisheries Department, Colony of North Borneo. The last collection was given to Chicago Natural History Museum when the Fisheries Department ceased operations. Inger participated in both expeditions; Chin shared the field work of the 1956 expedition and was a member of the Fisheries Department when its collections were made.

Specimens were borrowed from the Rijksmuseum van Natuurlijke Historie, Leiden, the Natural History Museum, Stanford University, and the United States National Museum. A few types were examined in the British Museum (Natural History).

Hook-and-line, minnow seines, trammel nets, cast nets, and traps were used to catch the fishes. The great majority of our specimens, however, were obtained through the use of rotenone in small streams. Most of our collecting effort was expended in small streams (1 to 10 meters wide), both clear and turbid and with various bottom characteristics. Rivers (i.e., streams wider than 10 meters and more than 50 km. long) were not sampled by means of rotenone; recovery of fishes was too uncertain in these large bodies of water. Consequently, our samples of the fauna in rivers are not as completely representative as those from small streams. As small streams of varying characteristics were treated with rotenone, which affects fishes of all habits—fossorial, benthic, mid-water and surface-dwelling, torrent-adapted, etc.—our samples from these streams are at least representative if not complete.

Vernier calipers graduated to 0.1 mm. were used for all measurements under 120 mm. Above that, a steel rule graduated in 0.5 mm. was used. Unless otherwise stated, the following conventions were adopted for measurements, body proportions, and counts: "Length" always refers to standard length, the distance from the tip of the snout to the caudal flexure. The following measurements are all given in terms of thousandths of the standard length: head length, measured from the tip of the snout to the end of the opercular flap; depth of body (cited as "depth"), the maximum behind the head; eye diameter; interorbital space; and the length of the head anterior to the eye ("snout"). All fin rays having separate bases were counted. Non-segmented hard rays (spines) are indicated by upper case Roman numerals. Non-branched, segmented rays are indicated by lower case Roman numerals. Branched segmented rays are indicated by Arabic numerals. If two separated dorsal fins are present, the counts for the two fins are separated by a dash (e.g., VI–I,6). Lateral line counts include all perforated scales be-

tween the upper corner of the opercle and the caudal flexure. Transverse scale counts were made between the lateral line and an imaginary mid-dorsal line just anterior to the dorsal fin, and between the lateral line and an imaginary mid-ventral line immediately anterior to the ventral fin; for example, the counts are indicated as 4½/1/3, the first number representing the count to the dorsal line, the second number the lateral line, and the last the count to the ventral line. Scale counts were made around the narrowest part of the caudal peduncle. Gill raker counts include all rudiments of the first arch.

Range and mean are given for all meristic characters such as fin ray and scale counts. Because the distributions of most ratios are unknown, we have given the median rather than the mean of the body proportions. "N" indicates the number of specimens on which a particular statistic is based.

At the end of each species account, a complete list of the North Bornean localities is given. If no material from a particular locality was seen, the authority in the literature is cited. Otherwise the number of specimens examined follows the place name.

The synonymies give the original reference, the first citation of the present name, the Weber and de Beaufort reference, and all papers subsequent to the publications of Weber and de Beaufort that give Bornean localities.

Gazetteer of Localities

Because of the difficulties of finding Bornean place names, many of which are not in atlases, a gazetteer to the localities mentioned in this report is presented. We have designated as "River" only major streams (length in excess of 60 km.). All other streams are referred to as "Sungei" (the local Malay usage). The Malay word "Danau" is used to indicate a cut-off meander.

Place	*District*	*Location*
Abai	Kinabatangan	5°42′N. 118°23′E.
Apin-apin, Sungei	Keningau	5°28′N. 116°16′E.
Balung, Sungei	Tawau	4°17′N. 118°12′E.
Banin-banan	Labuk and Sugut	5°55′N. 117°20′E.
Bettotan, Sungei	Sandakan	5°48′N. 117°50′E.
Bilit, Danau	Kinabatangan	5°30′N. 118°12′E.
Bongon	Kudat	6°33′N. 116°47′E.
Brakakis	Ranau	.....
Brantian, Sungei	Tawau	4°27′N. 117°34′E.
Bukit Basar	Kinabatangan	ca. 5°25′N. 117°40′E.

Place	*District*	*Location*
Bukit Garam, Danau	Kinabatangan	5°28′N. 117°52′E.
Bundu Tuhan	Ranau	5°58′N. 116°32′E.
Deramakot	Kinabatangan	5°18′N. 117°33′E.
Duadan, Danau	Kinabatangan	5°28′N. 117°52′E.
Edam, Sungei	Lahad Datu	5°02′N. 118°20′E.
Gaja, Sungei	Kinabatangan	5°30′N. 118°33′E.
Gum Gum, Sungei	Sandakan	5°55′N. 117°55′E.
Jesselton	Jesselton	5°51′N. 116°03′E.
Kabili, Sungei	Sandakan	empties into west end of Sandakan Harbor
Kaingeran, Sungei	Tambunan	5°40′N. 116°25′E.
Kalabakan	Tawau	4°25′N. 117°29′E.
Kalabakan River	Tawau	4°22′N. 117°35′E.
Kaung	Kota Belud	6°05′N. 116°27′E.
Kina Balu, Mount	Ranau	6°05′N. 116°30′E.
Kinabutan, Sungei	Tawau	4°15′N. 117°55′E.
Kiulu	Tuaran	6°04′N. 116°17′E.
Kota Belud	Kota Belud	6°22′N. 116°25′E.
Kretam, Bukit	Kinabatangan	5°30′N. 118°33′E.
Kretam Kechil, Sungei	Kinabatangan	5°31′N. 118°33′E.
Kuamut	Kinabatangan	5°13′N. 117°30′E.
Kuntong, Sungei	Kinabatangan	stream near Pintasan
Labuk River	Labuk and Sugut	5°55′N. 117°40′E.
Lahad Datu (Lahad Datu, Sungei = Edam, Sungei)	Lahad Datu	5°02′N. 118°20′E.
Lamag (Lamag Station = Lamag)	Kinabatangan	5°30′N. 117°50′E.
Malapi	Kinabatangan	5°30′N. 118°16′E.
Mapat, Sungei	Semporna	near Semporna (4°29′N. 118°37′E.)
Marabah	Beaufort	5°14′N. 115°38′E.
Marikut, Sungei	Tawau	4°27′N. 117°25′E.
Melantak	Sandakan	small settlement just west of Sandakan
Membikit, Sungei	Keningau	5°22′N. 116°06′E.
Mengalong River	Sipitang	5°02′N. 115°34′E.
Menggatal (Merabeh = Marabah)	Jesselton	6°03′N. 116°08′E.
Mintak	Kinabatangan	between Lamag and Bilit
Pegalan River	Tambunan	5°40′N. 116°23′E.
Pinang, Sungei	Kinabatangan	5°30′N. 118°33′E.
Pintasan	Kinabatangan	5°25′N. 117°43′E.
Purutan, Sungei	Tambunan	5°34′N. 116°18′E.
Sandakan	Sandakan	5°50′N. 118°05′E.
Sandala Estate	Sandakan	5°50′N. 117°57′E.
Sapagaya, Sungei	Sandakan	5°40′N. 118°06′E.
Sapong Estate	Tenom	5°03′N. 115°57′E.
Sebatik Island	Tawau	4°10′N. 117°45′E.
Segaliud River	Sandakan	5°45′N. 117°50′E.
Segama Estate	Lahad Datu	5°07′N. 118°15′E.
Segama River	Lahad Datu	5°30′N. 118°48′E.
Selimpopon River	Tawau	4°15′N. 117°35′E.
Sepilok, Sungei	Sandakan	5°48′N. 117°56′E.

Place	*District*	*Location*
Sibuga, Sungei	Sandakan	5°56′N. 118°03′E.
Tabalin Besar, Sungei	Kinabatangan	5°22′N. 117°39′E.
Tambisan Island	Kinabatangan	5°28′N. 119°07′E.
Tanah Merah	Sandakan	small settlement just west of Sandakan
Tawan, Sungei	Tawau	4°24′N. 117°27′E.
Tawau, Sungei	Tawau	4°15′N. 117°54′E.
Tempasuk River	Kota Belud	6°25′N. 116°22′E.
Tenosa	Sandakan	small settlement just northwest of Sandakan
Tuaran River	Tuaran	6°04′N. 116°17′E.

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The Environment

The whole island of Borneo was covered by forest prior to settlement by man. Western North Borneo, which is largely hilly or mountainous, has been under cultivation and, as a result, very little primary rain forest or cloud forest remains except in Beaufort and Sipitang Districts.

The eastern half of North Borneo, the area in which most of our field work was carried on, is still largely untouched. Low-level airplane flights crisscrossing this region reveal essentially continuous primary rain forest with its characteristic undulating but unbroken canopy (fig. 2). Inland from a 10- to 20-mile coastal belt, the forest is interrupted only by the major rivers and their roughly half-mile-wide strips of secondary growth. These distinctive bands of regenerating vegetation reflect for the most part abandoned cultivations or logging operations. Interior villages are small and widely separated until the central mountain ranges are reached and the impact of the peoples of the West Coast is seen. But in the lowlands of eastern North Borneo, the human population of the interior is concentrated in lumber camps or in a few copra and rubber plantations. In 1956, in the course of a 5-day trip covering about 300 km. of the Kinabatangan River, we saw fewer than 200 people living outside of these commercial camps.

Physiography.—Much of this section and the succeeding one on the geology are based on Reinhard and Wenk (1951) and the Annual Report for 1956 of the Geological Survey Department of British Borneo.

The outline of North Borneo has often been referred to as a hog's head facing eastward, the two erect ears formed by the two peninsulas facing Marudu Bay in the extreme north, the snout formed by the Dent Peninsula and the lower jaw by the Semporna Peninsula (fig. 1). The coast lines are broken, especially on the east where the entire northeastern coast is made up of a series of drowned river mouths.

The highest mountain is Mount Kina Balu (4100 meters), the highest peak between the Himalayas and the mountains of New

FIG. 2. Aerial view of rain forest of eastern North Borneo.

Guinea. Mount Kina Balu lies at the northern end of the Crocker Range, a northeast-southwest-trending ridge paralleling the western coast 20 to 30 km. inland. The Crocker Range is the only continuous ridge of altitudes exceeding 1000 meters above sea level. Low mountains are scattered in the south and west; the highest of them, Trus Madi, about 60 km. south of Kina Balu, is only 2300 meters high.

The rivers, such as the Kinabatangan, Labuk, Segama, and Sugut, draining into the Sulu Sea, flow through flat alluvial plains with a few, scattered, low hills around Sandakan Harbor and Dewhurst Bay and several 1000-meter mountains near the headwaters of the Labuk. The divides between these rivers are usually less than 500 meters high and often less than 100 meters. For much of their lengths the Kinabatangan and Segama have all of the aspects of physiographically old rivers: meandering courses and oxbow lakes. The watershed between these rivers and those (e.g., Padas River) flowing into the South China Sea is a broad, dissected peneplain about 500 meters high (Reinhard and Wenk, 1951).

The divide between the Sulu Sea drainages (Kinabatangan and Segama) and those (e.g., Brantian, Kalabakan, etc.) of the Celebes Sea lies in wild, rough country. In fact, the whole area south of the Segama and Kinabatangan rivers consists of a series of sharp ridges with almost no flat areas. Even the narrow flood plains are intersected by ridges running to the water's edge.

Geology.—Most of North Borneo is covered by Tertiary sediments with three large areas of pre-Tertiary sedimentary rocks in the north-central (Labuk), south-central (Pensianang), and central-eastern (Segama) areas. According to Reinhard and Wenk (op. cit.), the Tertiary deposits are generally thick and their lithology and disposition suggest the outlines of the geologic history.

Reinhard and Wenk visualize North Borneo in Eocene times as probably the site of a shallow sea dotted with a few small islands and surrounded by pre-Tertiary uplifts in the Labuk and Segama areas. The Eocene deposits appear to have been formed of pre-Tertiary material exposed to prolonged lateritic weathering and deposited in nearby shallow basins, one of which covered the entire Kinabatangan-Sandakan basin.

In late Oligocene times two large basins existed, separated by the pre-Tertiary uplands of the Labuk and Segama areas. One basin covered the entire northeastern portion of the country and the second the western, central, and southeastern parts. The Kinabatangan valley probably formed a channel between them, and the whole system was connected with the Sarawak-Brunei basin to the southwest and the Tarakan basin to the southeast. Coral limestones form the top of the Oligocene formation in the Kinabatangan basin.

In the Miocene, subsidence of the basins, interrupted by a brief period of diastrophism, probably was associated with the intrusion

of the Kina Balu igneous rocks. Limestones, however, were still being formed, especially in the Kinabatangan basin.

Very few Pliocene or Pleistocene formations have been identified. The Dent Peninsula in the east is topped by marine Pliocene sediments. Quaternary alluvial deposits have accumulated along the coasts.

Molengraaff (*in* Molengraaff and Weber, 1921) called attention to the influence of the Holarctic Pleistocene glaciations on the relations of the Greater Sunda Islands (Java, Sumatra, and Borneo) with the Asiatic mainland. Estimates of the lowering of sea level resulting from the northern glaciations vary from 70 meters (Kuenen, 1950) to 100 meters (Umbgrove, 1947; Zeuner, 1950). Assuming a drop in sea level of 40 fathoms (73 meters), Molengraaff showed that the Greater Sunda Islands formed part of the Asiatic land mass during the glacial periods (fig. 115) and that the traces of drowned river channels suggested that large parts of this enlarged land mass, which he called Sundaland, were drained by a single large river system. Subsequent studies (Umbgrove, op. cit.; Kuenen, op. cit.; Smit-Sibinga, *in* de Beaufort, 1951) have substantiated and expanded Molengraaff's findings. The Sunda River drained the western part of Borneo through the Kapuas River, most of Sumatra, and probably part of Malaya. A second river drained all of southern Borneo (from the Kumai to the Barito basins) and parts of Java. None of the maps published by the above authors show the Rejang River of Sarawak participating in these enlarged drainages. The rivers of the east coast of Borneo (e.g., Mahakam, Kajan, etc.) and all of those of North Borneo presumably had roughly the same courses in the Pleistocene as they have now and were not affected by the lowered sea level.

Weber (*in* Molengraaff and Weber, op. cit.) grasped the significance of these Pleistocene drainages in the history and distribution of fresh-water fishes, demonstrating his point by showing that the Kapuas fauna resembled that of eastern Sumatra more closely than that of another Bornean river, the Mahakam.

Although the western rivers from the Rejang northward apparently did not form part of the Sunda River drainage (see Kuenen, 1950, fig. 203), some faunal exchange may have occurred by means of stream piracy. Haile and Kirk (1957) observe that the headwaters of the Kapuas, Rejang, Mahakam, and Kajan rivers—four of the five largest rivers in Borneo—lie in an oval about 65 km. long and that the divide separating several of these drainages is as

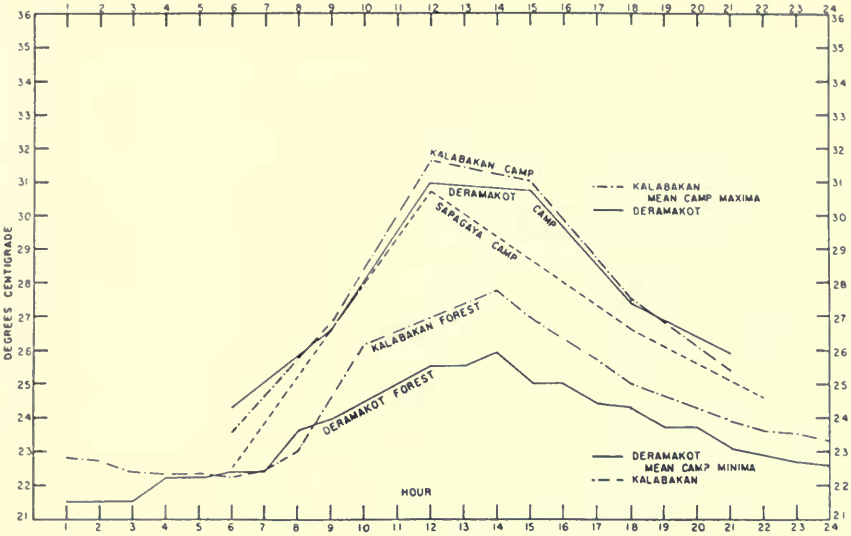

FIG. 3. Air temperatures at three localities in eastern North Borneo.

low as 600 meters above sea level. Reinhard and Wenk (1951 ,p .9) describe an almost certain case of stream piracy in extreme southeastern North Borneo.

Climate.—Lying between 3° 42′ N. and 7° 02′ N., North Borneo is entirely within the tropics. The average daily temperature calculated month by month at Sandakan (5° 54′ N., 118° 05′ E.) during the period 1953–58 varied between 26.1 and 27.2° C. (79.1–81.0° F.); at Jesselton (5° 51′ N., 116° 03′ E.) during the same interval the range was 25.6–27.0° C. (78.2–80.7° F.) (Summary of Observations, 1953–1958, Malayan Meterological Service, Singapore). The absolute extremes for that period were: Sandakan, 18.3–35.5° C. (65–96° F.); Jesselton, 18.9–35.0° C. (66–95° F.). At Keningau, in the interior of western North Borneo at 300 meters above sea level, the absolute extremes in the period 1955–59 were 15.0° and 35.5° C. (59–96° F.).

The temperatures recorded in the coastal cities are similar to those we recorded at three field camps just a short distance inland and at Deramakot, 90 km. from the coast. The extremes of temperature at Deramakot during our 23-day period of observation in April–May, 1956, were 22.2–34.4° C.; at Kalabakan for 30 days in June, 1956, 21.1–35.6° C. These observations were made with a minimum-

maximum thermometer. At Sapagaya for 18 days in July, 1950, the range was 20.6–32.2° C. At Bukit Kretam over a 52-day interval in May-June, 1950, the range was 22.0–32.5° C. The Sapagaya and Bukit Kretam extremes are based on temperatures recorded daily at hours 06, 12, 18, and 22; the true extremes for the periods of observation were almost certainly greater. The daily pattern of air temperatures in the camps is shown in figure 3. The camp temperatures represent means for the number of days indicated in the preceding paragraph; temperatures were recorded at hours 06, 09, 12, 15, 18, and 21 at Deramakot and Kalabakan, and at hours 06, 12, 18, and 22 at Sapagaya.

The camp and city temperatures are probably close to those of the air in any open situation such as above large rivers. But within the forest and, therefore, above and around small streams, air temperatures are lower. A continuously recording thermohumidigraph was set two meters above ground in the rain forest at Deramakot for three days and at Kalabakan for seven days. Figure 3 shows the hour by hour averages over the respective periods. The range of forest temperatures for these periods was 21.1–26.7° C. at Deramakot and 21.1–28.9° C. at Kalabakan. A hole in the forest canopy above the thermohumidigraph station at Kalabakan may account for the higher temperatures of the Kalabakan forest. The sun did not shine on the recorder but it undoubtedly elevated the temperature in the immediately surrounding space.

Rainfall averages more than 2540 mm. (100 inches) per year over much of the island of Borneo, and is well, though not uniformly, distributed throughout the year. Precipitation, at least along both coasts of North Borneo, is affected by monsoon winds. The northeast monsoon, usually from October to January or February, brings the heaviest rainfall of the year to the eastern coast of North Borneo, whereas the southwest monsoon from May to August or September brings heavy rains to the western coast (fig. 4). Fluctuations from year to year at any one place are often wide. During the six-year interval (1953–58) upon which figure 4 is based, the annual total at Jesselton ranged from 2412 to 3416 mm. (mean 2959 mm.), and at Sandakan from 2458 to 3794 mm. (mean 3054 mm.). In the same interval, at Sandakan rainfall varied from 33 to 269 mm. in April and from 114 to 775 mm. in January. Comparable year to year variation in monthly totals occurred at Jesselton.

Rainfall data are available for one field base, Kalabakan, within the same six-year interval. Between 1953 and 1958 annual rainfall

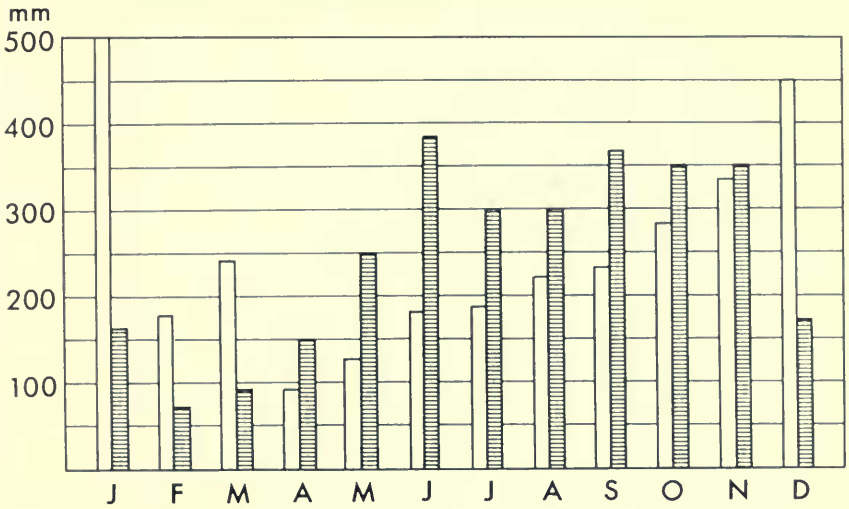

FIG. 4. Average monthly rainfall at Jesselton (shaded bars) and Sandakan (open bars), North Borneo, during the years 1953–58.

varied from 2217 to 2650 mm. (mean 2445 mm.). The monthly totals ranged between 82 (May) and 444 mm. (September). The maximum number of consecutive days without rain in 1954 and 1955 (the only years for which that information is available) were eleven and eight, respectively.

Heavy rains are often localized, with the result that 50 to 100 mm. may fall in an hour at one point while no rain is falling a kilometer away. As concerns the present study, the localization of heavy rainfalls frequently leads to radical and rapid modification of the aquatic environment at one point in a drainage while conditions 100 meters away remain just as they were during the preceding day or week. During the period 1953–58, the number of days having more than 50 mm. of rain varied from 13 to 21 per year at Jesselton and from 11 to 19 per year at Sandakan, with at least one occurring in every month during the six-year period.

General description of streams.—In Borneo, as elsewhere, the topography and geology determine the character of the streams and hence shape many of the environmental factors of the fish fauna. Much of the Segama and Kinabatangan basins is flat and covered with deep layers of alluvium. Every slight depression is saturated with water, and during the northeast monsoons (the heavier rains from October to February) large areas may be flooded. All streams

in this flat area have silt bottoms, turbid water, and slow current except after heavy rains.

The large rivers meander through this physiographically old region, flanked by numerous oxbow lakes in old channels (fig. 5). The rivers cut deeply into the alluvium, leaving steep banks as much as

FIG. 5. Meandering course of Kinabatangan River, eastern North Borneo, with cut-off oxbow in right foreground (between Sukau and Bilit).

15 meters high even as far upstream as Deramakot, 300 river km. from the mouth of the Kinabatangan. Even small streams (ca. 1 meter wide) have steep, high banks (ca. 2 meters). The height of the banks varies from day to day as even the largest rivers rise and fall rapidly in response to rainfall.

Wherever a ridge rises out of this relatively flat country, its streams have the characteristics of those in the Tawau region. In the latter region, where bedrock approaches the surface, small streams flow over mixtures of sand, gravel, and rock sorted according to local fluctuations in topography. Current varies from 1 to 3 meters per minute in the flats, and the water is usually clear. The large streams (e.g., the Kalabakan) in these areas have narrow flood plains and do not have cut-off oxbow lakes or meander to the same extent as do the rivers of the alluvial region. The accumulation of silt from all tributaries leaves these rivers *café-au-lait* brown and as turbid as the Kinabatangan. The bottoms vary in character. The rivers in the Tawau region usually have rocky bottoms despite the silt load. Banks are much less high than those of rivers in the alluvial region.

FIG. 6. Sungei Membikit, Keningau District, a typical stream of the mountainous west coast region of North Borneo.

Streams of the mountainous west coast area are swift and clear, and they flow over gravel and rock bottoms (fig. 6). A few of the rivers with longer courses and wider flood plains acquire enough silt from their tributaries to take on the characteristics of the eastern rivers, the Padas about 65 km. from the sea and the Tuaran about 8 km. from the sea.

Water temperatures are relatively high and constant. Readings made between the hours of 08 and 14 in the Bukit Kretam (in 1950) and Deramakot areas (in 1956) were 25–27° C. in all shaded, forest streams. Surface temperatures of the Kinabatangan River at Dera-

FIG. 7. Stream bed partially shaded by forest canopy.

makot, recorded two meters from the bank at 06 hours May 10–17, 1956, ranged from 25.4–26.4° (mean 25.75°). At 15 hours the range was 26.0–26.8° (mean 26.30°) and at 18 hours 26.0–26.8° (mean 26.36°). The water was not shaded where the river temperatures were taken.

The highest surface water temperature recorded was 32° C., recorded once at 15 hours at the mouth of the Sungei Deramakot where the water was fully exposed to sunlight. Air temperature in the shade was 31° C. at that time.

The lowest water temperature we have recorded is 21° C.; this reading was obtained in the Sungei Kaingeran where this mountain stream intersects the Pegalan River.

Vegetation.—As noted above, much of western North Borneo and the littoral and riparian fringes of eastern North Borneo are under cultivation or covered by secondary growth. Primary vegetation in the other parts of North Borneo consists of lowland rain forest. Detailed accounts of the Bornean rain forests are given by Richards (1952) and Browne (1955). Here it is sufficient to say that these

broad-leaved, evergreen forests have closed canopies usually 45 to 65 meters above the ground. Mature trees forming the canopy shade any stream narrower than 10 meters, although small patches of sunlight may spot any given area (fig. 7). Undergrowth and floor litter are much more abundant in flat land, such as that in the Kinabatangan basin, than on hillsides.

As soon as the primary forest is cut over, a dense tangle of vines and small trees springs up unless the land is kept clear for cultivation. Once cultivated land has been abandoned, the same tangled secondary growth develops. Secondary growth trees are rarely more than 20 meters high and usually shorter. As a result streams even 5 meters wide are not shaded except at the banks—the only obvious effect we have observed on the aquatic environment.

Fauna.—As elsewhere in the tropics, invertebrates dominate the Bornean fauna. Insects having aquatic larvae or nymphs are abundant in every stream, Plecoptera, Neuroptera, Trichoptera, and Diptera being most numerous in the stomachs of fishes. Ants, spiders, and Orthoptera are the most conspicuously abundant terrestrial invertebrates and many, particularly ants, fall from vegetation into streams and are eaten by fishes (Inger, 1955). Decapod crustaceans are abundant in all streams of all sizes and form an important segment of the food supply for fishes.

The vertebrate fauna includes upward of 200 species of reptiles and amphibians. Several genera of snakes (e.g., *Natrix, Cerberus, Enhydris, Acrochordus*) feed to varying degrees on fishes. Aquatic larvae of amphibians are eaten by fishes. Otters are the mammals most likely to have an impact on the fish community; a *Leiocassis* found 25 meters from the Kinabatangan with its head eaten off was presumed to be the prey of an otter. Potential fish predators among birds include anhingas, egrets, and kingfishers.

SYSTEMATICS

Key to Major Categories of Fishes from Fresh Waters of North Borneo (figs. 8, 9)

1A. Snout with a flexible, fleshy appendage (fig. 9, A); no ventral fins. *Mastacembelidae* (p. 34).

B. Snout without flexible, fleshy appendage; ventral fins present or absent . . 2.

2A. Body without scales, or with scales deeply imbedded in the skin and superficially not visible . . . 3.

B. Body covered with distinct scales or bony plates . . . 8.

3A. Ventral fins present (fig. 9, B) . . . 4.

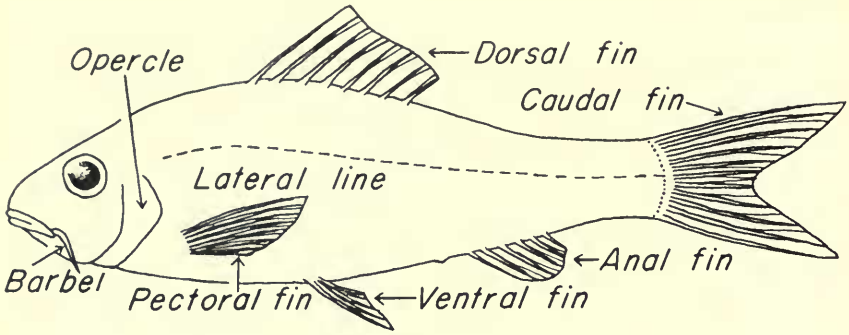

FIG. 8. Generalized outline of fish.

B. Ventral fins absent (fig. 9, C) ..... 6.
4A. Ventral fins united (fig. 9, D) ..... *Taenioididae* (p. 189).
B. Ventral fins separated (fig. 9, B) ..... 5.
5A. Pectoral fin with a strong, hard spine ..... *Siluroidea* (p. 126).
B. Pectoral fin without spine ..... *Cyprinoidea* (part; p. 40).
6A. Dorsal and anal fins short, separated from caudal, with clearly visible rays (fig. 9, E); body not eel-shaped ..... *Tetraodontidae* (p. 189).
B. Eels; dorsal and anal long, confluent with caudal (fig. 9, F) ..... 7.
7A. Gill openings ventral, median (fig. 9, G) ..... *Synbranchidae* (p. 40).
B. Gill openings widely separated, lateral (fig. 9, H) ..... *Anguillidae* (p. 37).
8A. Body encased in hard bony plates; snout tubular and bony (fig. 9, I). *Syngnathidae* (p. 154).
B. Body covered with normal scales ..... 9.
9A. Lower jaw prolonged into a beak (fig. 9, J) ..... *Hemiramphidae* (p. 152).
B. Lower jaw not prolonged into a beak ..... 10.
10A. Dorsal fin single* (fig. 9, K) ..... 11.
B. Dorsal fin divided into two separated portions (fig. 9, L) ..... 22.
11A. Lateral line extending on to caudal fin (fig. 9, M) ..... *Sciaenidae* (p. 166).
B. Lateral line ending at base of caudal fin ..... 12.
12A. Anal fin with at least 3 hard, inflexible spines (fig. 9, N) ..... 13.
B. Anal fin with at most one stiff spine ..... 17.
13A. Anal fin with 3 spines ..... 14.
B. Anal fin with more than 3 spines ..... *Anabantidae* (part; p. 156).
14A. Spinous part of dorsal fin with a deep notch (fig. 9, O). *Ambassidae* (p. 164).
B. Dorsal fin without a notch (fig. 9, K) ..... 15.
15A. Dorsal fin with 4–6 spines ..... *Toxotidae* (p. 165).
B. Dorsal fin with 9–16 spines ..... 16.

* The dorsal fin in the Ambassidae has a deep notch (fig. 9, O), but the two parts of the fin are connected by membrane.

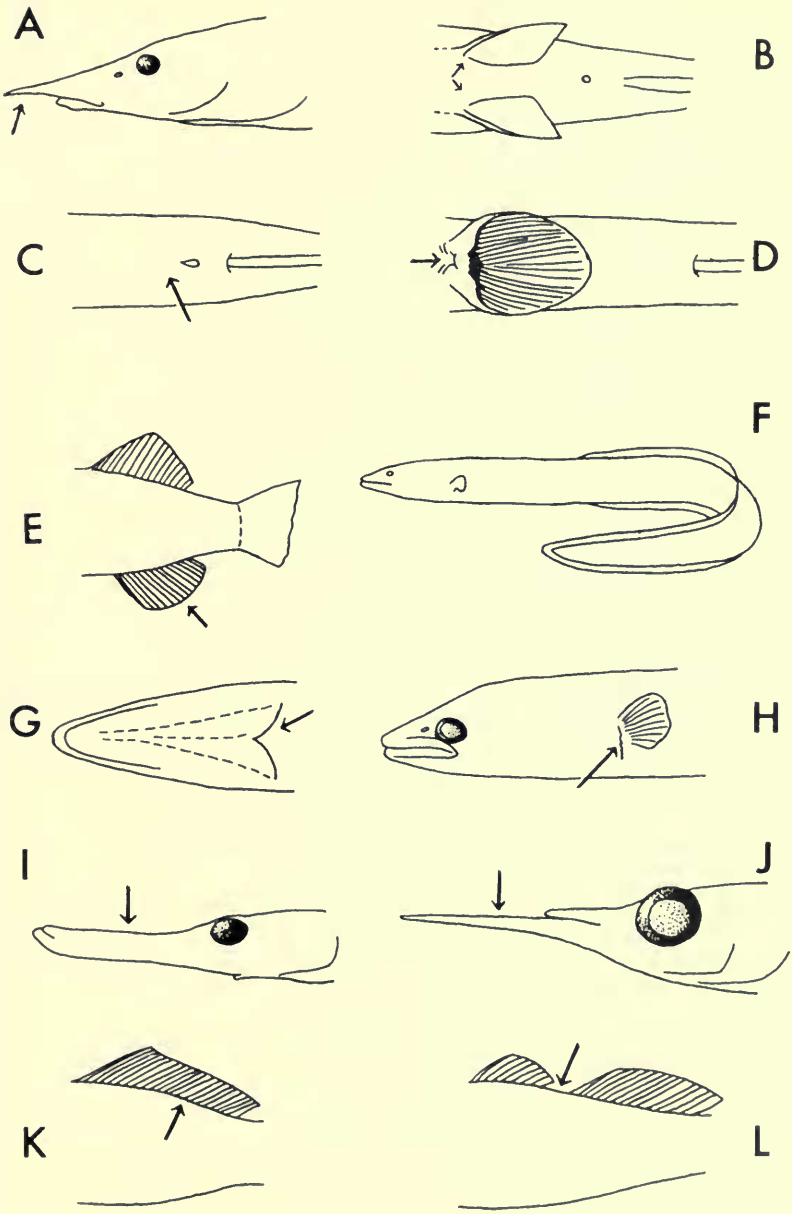

FIG. 9. Key to major categories of fishes.

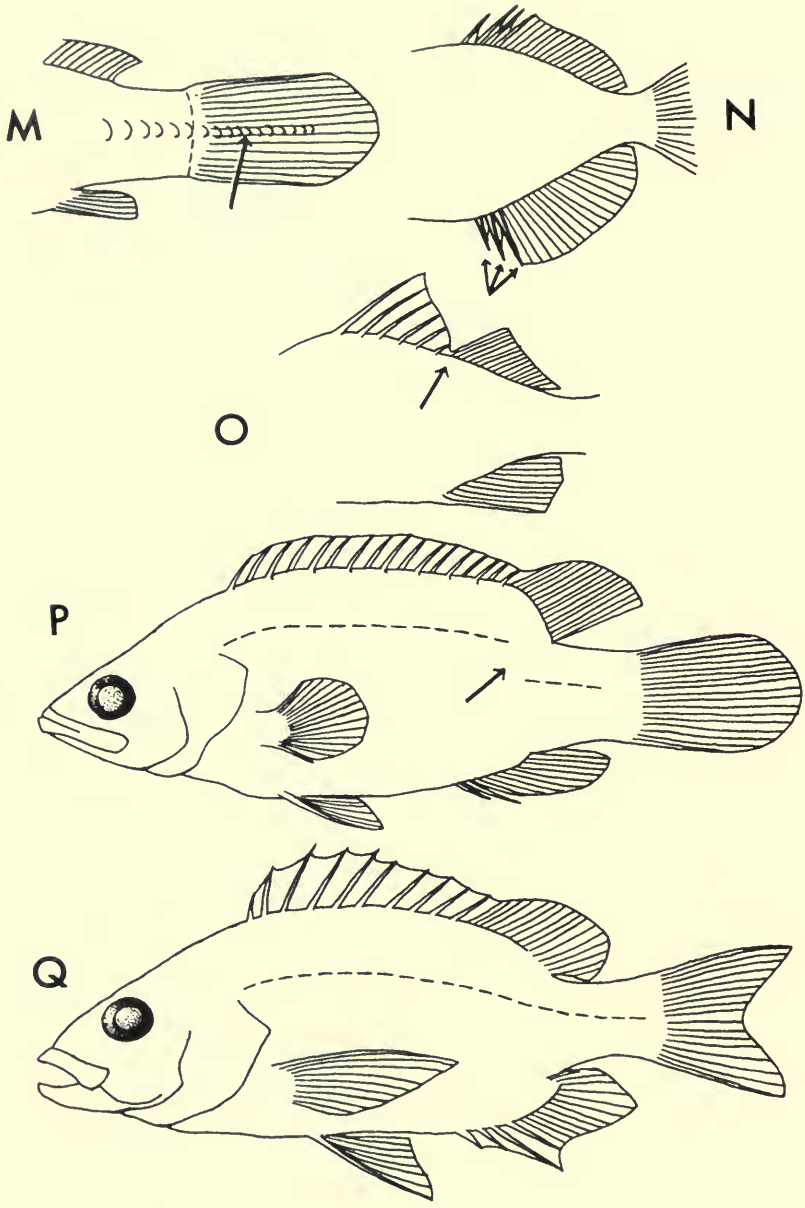

FIG. 9 (*continued*). Key to major categories of fishes.

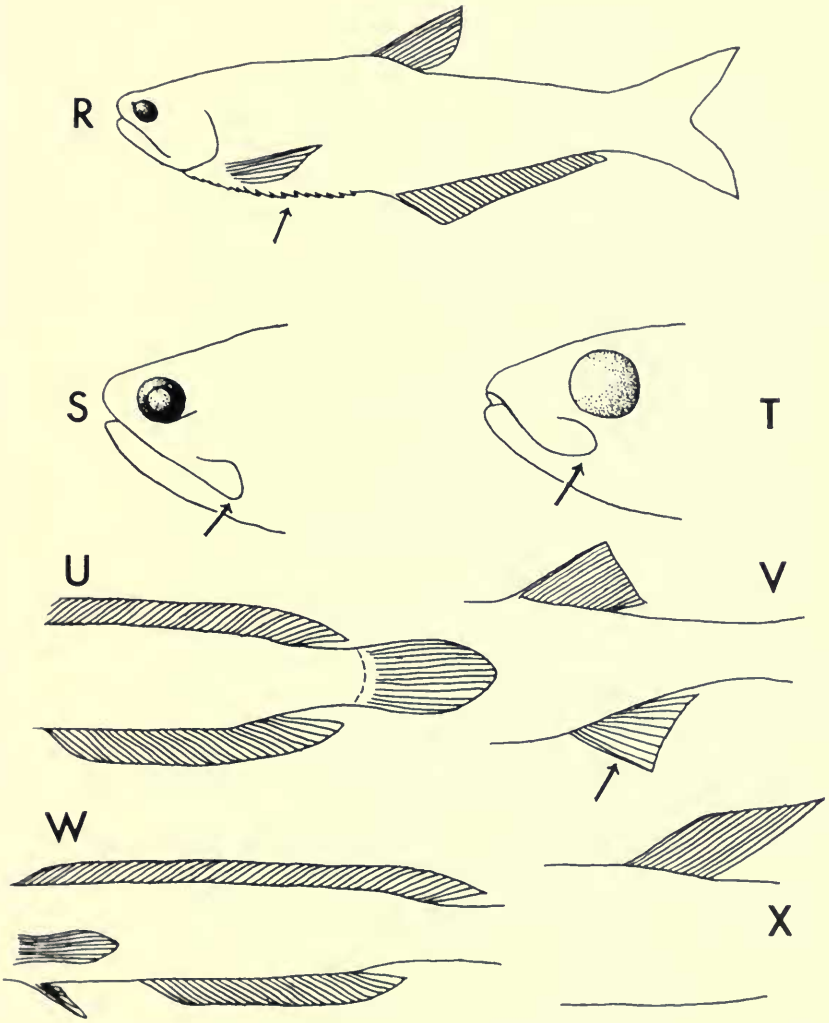

FIG. 9 (*continued*). Key to major categories of fishes.

16A. Lateral line interrupted (fig. 9, P) ..... *Nandidae* (p. 164).
B. Lateral line continuous (fig. 9, Q) ..... *Lutianidae* (p. 167).
17A. Belly with strong spiny scutes (fig. 9, R) ..... 18.
B. Belly without spiny scutes ..... 19.
18A. Mouth extending behind level of eye (fig. 9, S) ..... *Engraulidae* (p. 33).
B. Mouth not extending behind eye (fig. 9, T) ..... *Clupeidae* (p. 32).
19A. Anal fin with more than 20 rays (fig. 9, U) ..... 20.
B. Anal fin with less than 15 rays (fig. 9, V) ..... 21.

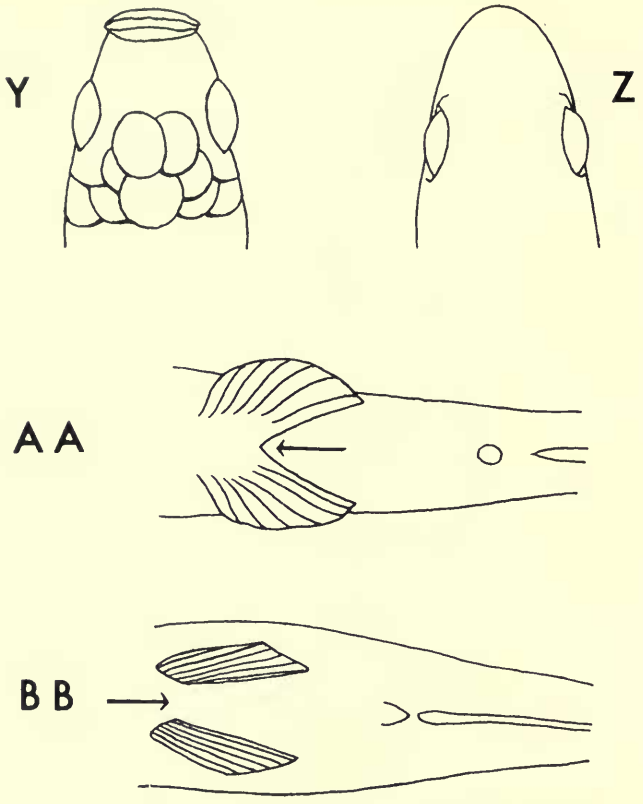

FIG. 9 (*continued*). Key to major categories of fishes.

20A. Dorsal fin with more than 30 rays (fig. 9, W) ..... *Ophicephalidae* (p. 154).
B. Dorsal fin with less than 10 rays (fig. 9, X) ..... *Anabantidae* (part; p. 156).
21A. Top of head scaled (fig. 9, Y) ..... *Poeciliidae* (p. 152).
B. Top of head never scaled (fig. 9, Z) ..... *Cyprinoidea* (part; p. 40).
22A. Ventral fins united (fig. 9, D, AA) ..... *Gobiidae* (p. 176).
B. Ventral fins separated (fig. 9, BB) ..... *Eleotridae* (p. 167).

CLUPEIDAE

Corica soborna Hamilton

Corica soborna Hamilton, 1822, Fishes of Ganges, p. 253—Mahanandra River, India.

Dorsal ii,13; pectoral i,12; ventral i,6; anal iii,13+2; mid-lateral scales 40; transverse scales 10; abdominal scutes 19 (8 post-ventral);

gill rakers (lower arch) 24; head 0.219; depth 0.263; snout 0.063; eye 0.076; interorbital 0.054; standard length 45.5 mm.; total length 54.8 mm.

Color in life silvery, with a mid-lateral yellowish stripe; fins colorless.

This species, normally found in brackish water, moves up larger rivers into fresh water. The specimen listed was caught in turbid water at the mouth of a small tributary of the Kinabatangan.

Locality.—Kinabatangan District, small stream one mile above mouth of Sungei Tabalin Besar (1).

ENGRAULIDAE

Setipinna melanochir (Bleeker). Figure 10.

Engraulis melanochir Bleeker, 1849, Verh. Bat. Gen., **22**: 13—Madura.

Setipinna melanochir Bleeker, 1866–72, Atlas Ichth., **6**: 136; Weber and de Beaufort, 1913, Fishes Indo-Austr. Arch., **2**: 26, fig. 15; Hardenberg, 1937, Treubia, **16**: 8.

Dorsal I,iii,9–11 (mean I,iii,10.6; N=8); pectoral i,12–13 (mean i,12.6; N=8); ventral i,6 (N=8); anal ii,41–46 (mean ii,42.7; N=8); mid-lateral scales 43–49 (mean 46.1; N=9); transverse scales 12–14 (mean 13; N=7); abdominal scutes 34–41, post-ventral 11–13 (mean post-ventral 12.1; N=9); branchiostegals 14–15; gill rakers 9–11+ 10–12, total 20–23 (mean total 21.3; N=8); head 0.173–0.199 (median 0.187; N=9); depth 0.286–0.336 (median 0.306; N=9); snout 0.018–0.029 (median 0.023; N=9); eye 0.037–0.052 (median 0.043; N=9); interorbital 0.040–0.050 (median 0.046; N=9); standard length 111.5–248.0 mm.; total length 131.5–290.0 mm.

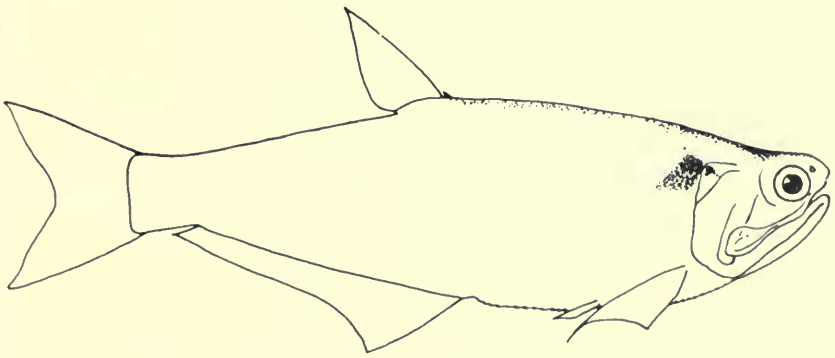

FIG. 10. *Setipinna melanochir.*

Color silvery, edge of back blackish olive; some larger specimens with a black spot just behind opercle and with black pectoral fins; other specimens with colorless pectoral; other fins colorless.

Two females (220 and 248 mm.) contained enlarged ova.

All specimens were caught in the turbid waters of the Kinabatangan River or at the mouth of Sungei Deramakot. Five (127.5–179.5 mm.) were caught with a cast net and five (111.5–248.0 mm.) in a trammel net at depths of 30 to 95 cm. The trammel net was set across the mouth of Sungei Deramakot and the fishes were caught as they moved upstream.

Five of the specimens had eaten small fishes (about 15 mm.) and two had fed on small prawns (18 mm.).

Local name.—"Puput" (Malay).

Locality.—Kinabatangan District, Deramakot (10).

MASTACEMBELIDAE

KEY TO SPECIES KNOWN FROM NORTH BORNEO

1A. Caudal fin not separated from dorsal and anal by notches (fig. 11, A). *maculatus.*

B. Caudal fin separated from dorsal and anal by notches (fig. 11, B).....2.

2A. Body with distinct vertical bands; pectoral without black spots.....*keithi.*

B. Body mottled; pectoral with conspicuous black spot at base, usually several spots distally.....*armatus.*

Fishes of the genus *Mastacembelus* are called "Salan" by the Dusuns of North Borneo.

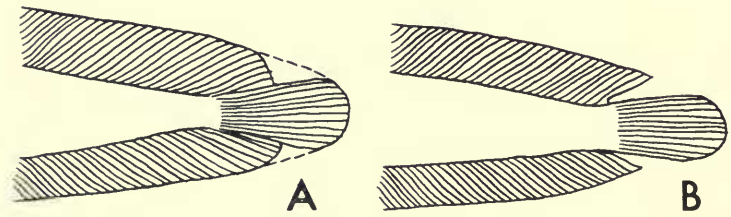

FIG. 11. Key to species of Mastacembelidae.

Mastacembelus maculatus Valenciennes

Mastacembelus maculatus Valenciennes *in* Cuvier and Valenciennes, 1831, Hist. Nat. Poissons, 8: 461—Moluccas; Sufi, 1956, Bull. Raffles Mus., no. 27, p. 113, pl. 16, fig. 16, pl. 20, fig. 15.

Dorsal XXVII–XXVIII,55–58; pectoral 22–25; anal III,49–54, scale rows between lateral line and base of first soft dorsal 17–23; preopercular spines 2–3; head 0.175; standard length 123–150 mm.; total length 130–160 mm.

Sarawak specimens (CNHM 45876, 68495–8) have more soft dorsal (60–63) and soft anal rays (58–63), and fewer scale rows (12–14) above the lateral line.

Color (based on Sarawak specimens) in alcohol purplish brown, with indistinct, darker, vertical bars on body; under side of head distinctly barred with dark brown and pale yellow; pectoral fin with faint dark checks; vertical fins of fishes less than 150 mm. long with numerous dark checks usually forming narrow oblique dark bars; in larger specimens, these bars are obscured; all specimens with large, squarish, dark spots at base of dorsal.

The North Bornean fishes were caught in clear water over rocky bottoms.

Localities.—Beaufort District, Marabah (Sufi, 1956); Kota Belud District, Tempasuk River (1); Ranau District, Ranau (2).

Mastacembelus keithi Herre. Figure 12.

Mastacembelus keithi Herre, 1940, Bull. Raffles Mus., no. 16, p. 24, pl. 19—Segaliud River, North Borneo; Sufi, 1956, op. cit., no. 27, p. 117, pl. 21, fig. 18.

Dorsal XXV–XXIX,52–61 (mean of spines 26.3, N=24; mean of soft rays 55.9, N=21), total rays 78–86; pectoral 23–27 (mean 24.4; N=18); anal III,52–61 (mean III,55.1; N=20); scale rows between lateral line and base of first soft dorsal 18–25 (mean 21.3; N=17); preopercular spines 2 (3 in 3 out of 20 specimens); head (including rostral appendage) 0.197–0.258 (median 0.217; N=9); depth 0.133–0.145 (median 0.140; N=6); standard length 40.5–236.0 mm.; total length 49–252 mm.

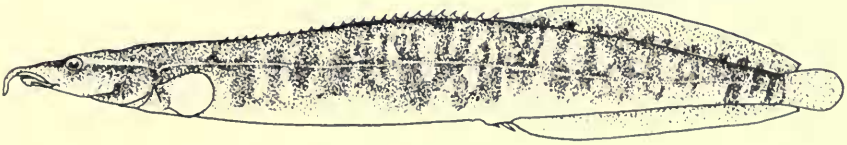

FIG. 12. *Mastacembelus keithi.*

Color in alcohol brownish with dark vertical bands; lighter interspaces subequal to dark bands; small light spots in dark bands, espe-

cially below lateral line; a narrow dark stripe from rostral appendage through lower half of eye to opercle, obscure in larger specimens; under side of head cream-colored or dusky, without dark markings; vertical fins dark, markings obscure or absent; pectoral colorless.

Specimens were caught in small to medium-sized forest streams (ca. 1–8 meters wide), though four were taken in a small stream in a rubber plantation. Thirty-nine were in clear water and four in turbid; eight were caught over silty bottoms, nine over a mixture of silt and gravel, seven over sand and gravel, and eighteen over gravel and rock.

Localities.—Kinabatangan District, Deramakot (30); Sandakan District, Sungei Gum Gum and Segaliud (Herre, 1940a), Sungei Kabili (1 paratype), Mile 16, Labuk Road, Sandakan (4), tributary of Sungei Sapagaya (9).

Mastacembelus armatus (Lacépède). Figure 13.

Macrognathus armatus Lacépède, 1800, Hist. Nat. Poissons, **2**: 286—no locality.

Mastacembelus armatus Valenciennes *in* Cuvier and Valenciennes, 1831, Hist. Nat. Poissons, **8**: 456, pl. 240; Sufi, 1956, Bull. Raffles Mus., no. 27, p. 134, pls. 25–26.

Dorsal XXXI–XXXII,70–75 (mean of soft rays 72.0; N=5), total rays 102–107; pectoral 21–23 (mean 22.4; N=5); anal III,65–72 (mean III,68.4; N=5); scale rows between lateral line and base of first soft dorsal 29–32 (mean 30.4; N=5); preopercular spines 2; head (including rostral appendage) 0.201–0.214 (median 0.207; N=5); depth 0.110–0.115 (median 0.113; N=4); standard length 108–169 mm.; total length 114–178 mm.

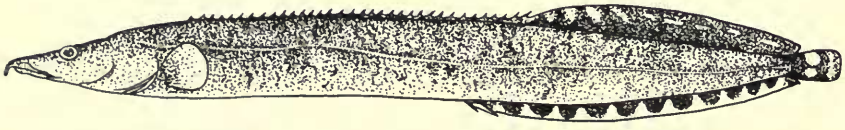

FIG. 13. *Mastacembelus armatus.*

Color in alcohol brownish with dark mottling, obscure in largest specimens; under side of head cream-colored, uniform; pectoral with a dark spot at its base and usually several spots distally; vertical fins with a light margin, basally dark brown; light projections from margin invade dark base of vertical fins in specimens smaller than 150 mm.

The above description is based on North Bornean specimens. Fishes from central and northern Sarawak (CNHM 68484–7) have the same color pattern and body proportions but differ slightly in counts (see Table 1). All Bornean specimens have shallow, but distinct notches separating dorsal, caudal, and anal fins. In this regard they differ from all Malayan fishes examined (CNHM 50777, 60272, 62012), which have smoothly confluent vertical fins. None of the Malayan fishes, all of which have a reticulate body pattern, has light-margined vertical fins such as characterize the Bornean specimens of all sizes (up to 260 mm.).

TABLE 1.—Frequency Distribution of *Mastacembelus armatus* of Borneo with Respect to Several Characters

	Preopercular Spines			Scales between Lateral Line and First Soft Dorsal						
	2	*3*	*4*	*29*	*30*	*31*	*32*	*33*	*34*	*35*
Eastern North Borneo....	4	0	0	2	0	2	1	0	0	0
Central Sarawak.....	1	10	2	0	0	2	1	3	2	2

	Dorsal Spines				
	31	*32*	*33*	*34*	*35*
Eastern North Borneo....	1	4	0	0	0
Central Sarawak.....	0	0	2	4	5

	Soft Dorsal Rays											
	70	*71*	*72*	*73*	*74*	*75*	*76*	*77*	*78*	*79*	*80*	*81*
Eastern North Borneo....	2	0	1	1	0	1	0	0	0	0	0	0
Central Sarawak.....	0	0	0	1	2	2	1	3	0	0	1	1

All the Bornean specimens were caught in clear water above gravel and rock bottoms in small (ca. 3 meters wide) forest streams.

One stomach contained Plecoptera nymphs; a second, Odonata and Plecoptera nymphs and a Neuroptera larva; and a third, a Plecoptera nymph and Trichoptera larvae.

Localities.—Kinabatangan District, Deramakot (1); Tawau District, Kalabakan, Sungei Tawan (4).

ANGUILLIDAE

KEY TO SPECIES KNOWN FROM NORTH BORNEO

1A. Body covered with dark mottling (fig. 14, C) ..... *marmorata.*
B. Body not mottled ..... 2.
2A. Origin of dorsal approximately opposite anus (fig. 14, A) ... *bicolor pacifica.*

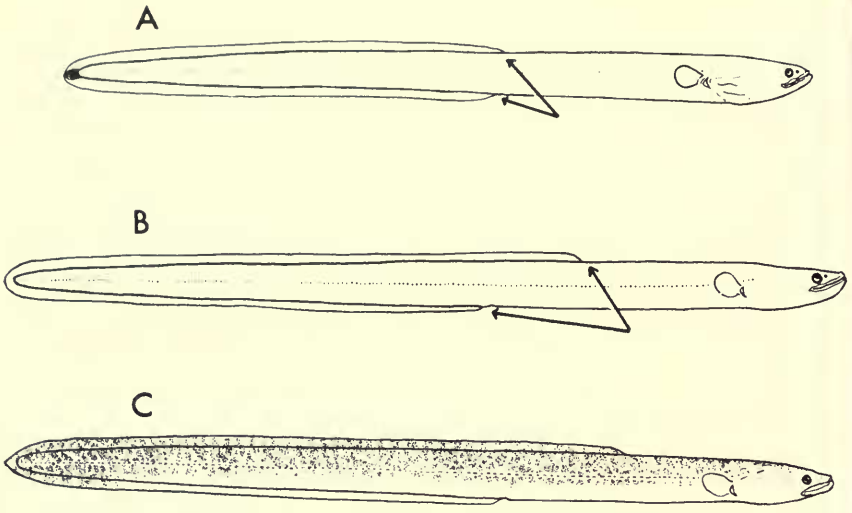

FIG. 14. A, *Anguilla bicolor*. B, *A. borneensis*. C, *A. marmorata*.

B. Origin of dorsal approximately midway between gill opening and anus (fig. 14, B) ..... *borneensis*.

All body ratios of eels are given here in terms of total length.

Eels of this family are called "Tadung" (Malay) and "Butul," "Roluo," and "Sinsilud" (Dusun and Orang Sungei).

Anguilla marmorata Quoy and Gaimard. Figure 14, C.

Anguilla marmorata Quoy and Gaimard, 1824, Voy. Uranie, Zool., p. 241, pl. 51, fig. 2—Waigeo; Ege, 1939, Dana Rep., no. 16, p. 36, pl. 1, fig. 8, text figs. 12 and 14.

Anguilla mauritiana Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., 3: 245 (part).

Pectoral 16–17 (mean 16.4; N=13); head 0.135–0.160 (median 0.146; N=16); predorsal length 0.251–0.321 (median 0.283; N=16); preanal length (distance between snout and anus) 0.400–0.442 (median 0.419; N=16); total length 89.0–490.0 mm.

Dentition as figured by Ege (1939, fig. 14, nos. 8 and 9).

Color dark brown above, lighter below, the dark area extending low on sides and covered with darker mottling; dorsal fin dark, mottled, usually with a narrow light margin.

All specimens were collected in a small, clear forest stream.

Of the ten food-containing stomachs examined, two held crabs; two, Plecoptera nymphs; one, numerous blackfly larvae; two, insect fragments; and one, parts of an earthworm. All nine specimens larger than 240 mm. were heavily infested with nematode worms.

Locality.—Tawau District, Kalabakan, Sungei Tawan (14).

Anguilla bicolor pacifica Schmidt. Figure 14, A.

Anguilla pacifica Schmidt, 1928, Rec. Austr. Mus., **16**: 190–191—Philippines to New Guinea.

Anguilla bicolor pacifica Ege, 1939, Dana Rep., no. 16, p. 151, pl. 2, fig. 7, text figs. 34 and 39.

Anguilla spengeli Weber, 1912, Zool. Jahrb., suppl. 15, **1**: 591; Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 249.

Pectoral 16–17 (mean 16.6; N=5); head 0.130–0.149 (median 0.139; N=8); predorsal length 0.376–0.422 (median 0.397; N=8); preanal length 0.386–0.412 (median 0.396; N=8); total length 79.0–252.0 mm.

Dentition as figured by Ege (1939, fig. 39, no. 12).

Dark brown above, lighter below; dorsal fin dusky; anal fin light anteriorly, becoming darker posteriorly.

All specimens were collected in small forest streams, five in turbid water and twelve in clear water.

One stomach contained an Ephemeroptera nymph and the tail of a tadpole. A second stomach contained one Odonata nymph, two Plecoptera nymphs and one Ephemeroptera nymph.

Localities.—Tawau District, Kalabakan, Sungei Marikut (5), Sungei Tawan (12).

Anguilla borneensis Popta. Figure 14, B.

Anguilla borneensis Popta, 1924, Zool. Meded., **8**: 73, figs. *a*, *b*—Bo River, Borneo; Ege, 1939, Dana Rep., no. 16, p. 89, pl. 2, fig. 1, text figs. 16–23.

Anguilla celebesensis Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 247 (part).

Pectoral 16–19 (mean 17.7; N=22); head 0.118–0.167 (median 0.145; N=31); predorsal length 0.269–0.349 (median 0.311; N=31); preanal length 0.366–0.473 (median 0.429; N=31); total length 86.0–537.0 mm.

Dentition as figured by Ege (1939, fig. 23, no. 3).

Color dark brown above, pale yellowish below, the ventrad extension of the dark pigment varying; no markings; dorsal fin with

a light margin; anal fin light anteriorly, gradually becoming darker posteriorly with a light margin.

Most of our specimens were collected in small forest streams, although four were taken from streams running through heavily populated areas or rubber plantations. Eleven were collected in turbid water and 206 in clear water.

Of the thirteen food-containing stomachs examined, seven held crabs; two, aquatic insects; four, terrestrial invertebrates; and one, a caecilian.

Localities.—Kinabatangan District, Deramakot (85), Sungei Gaja (79), unnamed tributary of Sungei Kretam Kechil (27), Lamag (1), Sungei Pinang (3); Sandakan District, Sandakan (4), tributary of Sungei Sapagaya (5), Sepilok Forest Reserve (2); Tawau District, Kalabakan, Sungei Tawan (10), Sungei Marikut (1).

SYNBRANCHIDAE

Monopterus albus (Zuiew)

Muraena alba Zuiew, 1793, Nova Acta Acad. Sci. Petrop., **7**: 299, pl. 7, fig. 2—not seen.

Monopterus albus Jordan and Snyder, 1901, Proc. U. S. Nat. Mus., **23**: 838; Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 413, figs. 210–211; Inger, 1955, Fieldiana: Zool., **37**: 59.

Total length 120–431 mm.; snout-vent length 79–296 mm.; snout-vent 0.662–0.704 of total; head 0.062–0.070 of total, 0.092–0.102 of snout-vent; depth 0.028–0.035 of total, 0.044–0.050 of snout-vent.

Body slate brown above, whitish or light brown below, with small dark spots on sides and sometimes on the ventral surface.

Specimens were collected in clear water in small streams having silt or gravel bottoms.

Local names.—"Belut" (Malay), "Hindung" or "Lindung" (Orang Sungei), and "Timpadang-padang" (Dusun).

Localities.—Kinabatangan District, Sungei Gaja (2); Sandakan District, Sandala Estate (1).

CYPRINOIDEA

KEY TO FAMILIES FROM NORTH BORNEO

1A. At least three pairs of barbels (fig. 15, A) ..... 2.
B. None, one, or two pairs of barbels (fig. 15, B) ..... *Cyprinidae.*

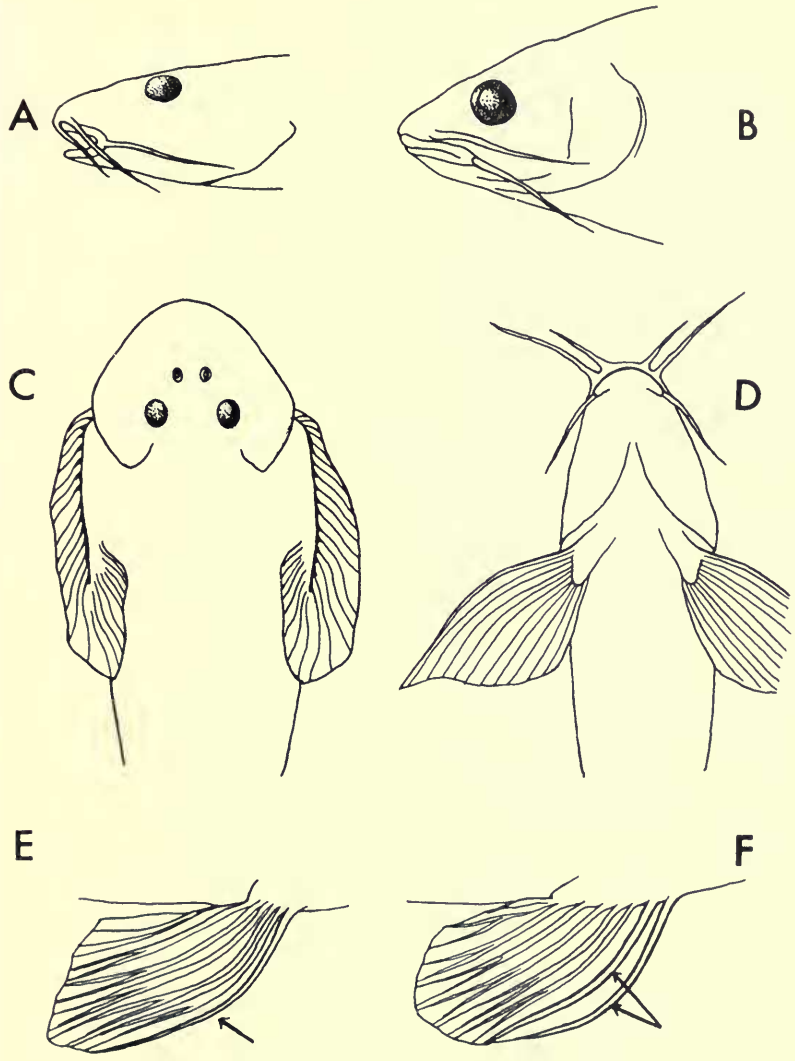

FIG. 15. Key to families of Cyprinoidea.

2A. Pectoral fin horizontal, fan-shaped, and with posterior rays lying flat against side of body (fig. 15, C) ..... *Gastromyzontidae.*

B. Pectoral fin horizontal or oblique, posterior rays not flattened against side of body (fig. 15, D) ..... 3.

3A. Pectoral and ventral fins with only one unbranched ray (fig. 15, E). *Cobitidae.*

B. Pectoral and ventral fins with at least two unbranched rays (fig. 15, F). *Homalopteridae.*

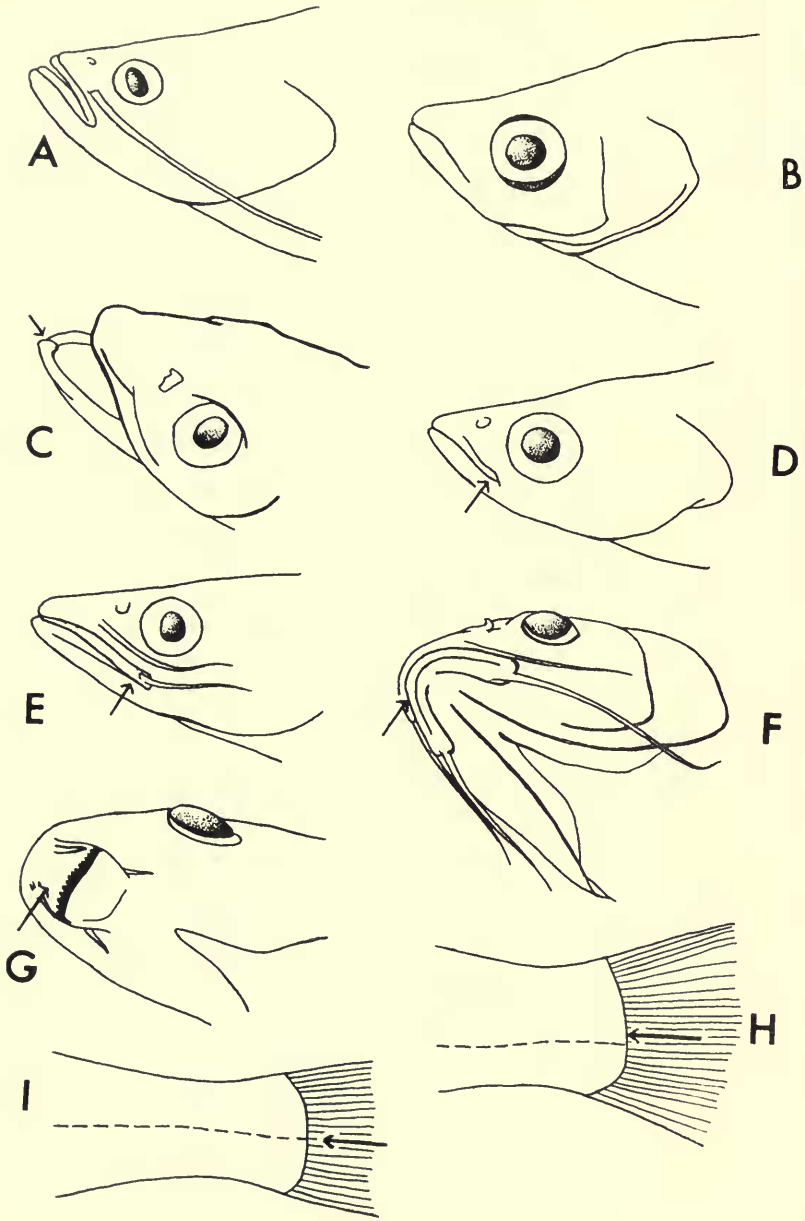

FIG. 16. Key to genera of Cyprinidae.

CYPRINIDAE

Key to Genera from North Borneo

1A. Body compressed; abdomen keeled (Abraminae) ..... 2.
B. Body various; ventral edge not keeled ..... 3.
2A. A pair of long maxillary barbels (fig. 16, A) ..... *Nematabramis.*
B. No barbels (fig. 16, B) ..... *Chela.*
3A. Lower jaw with a knob at symphysis fitting into emargination of upper jaw (fig. 16, C); lateral line markedly curved downward behind base of pectorals (Rasborinae) ..... 4.
B. No symphyseal knob in lower jaw; lateral line with at most a slight downward curve ..... 5.
4A. Barbels absent; mouth small, gape not longer than eye diameter (fig. 16, D). *Rasbora.*
B. Barbels present, though very short in one species; mouth large, gape about twice length of eye diameter (fig. 16, E) ..... *Luciosoma.*
5A. Upper lip separated from snout by a deep groove (Cyprininae) (fig. 16, F) .. 6.
B. No groove separating snout and upper lip (Garrinae) (fig. 16, G) ..... 15.
6A. Lateral line ending below middle of caudal base (fig. 16, H); two pairs of barbels; last simple dorsal ray non-denticulate (fig. 16, K) ... *Leptobarbus.*
B. Lateral line ending in mid-line of caudal base (fig. 16, I); other characters various ..... 7.
7A. Last simple dorsal ray denticulate on posterior border (fig. 16, J) ..... 8.
B. Last simple dorsal ray non-denticulate (fig. 16, K) ..... 10.
8A. Fine ridges and folds across top and sides of head (fig. 16, L). *Cyclocheilichthys.*
B. No such structures on head ..... 9.
9A. No barbels or two pairs ..... *Puntius.*
B. One pair of barbels (fig. 16, M) ..... *Hampala.*
10A. Branched dorsal rays less than 10 ..... 11.
B. Branched dorsal rays 10–30 ..... 14.
11A. Lower lip with a median lobe free anteriorly and fused to the chin posteriorly (fig. 16, N) ..... 12.
B. Lower lip with a median lobe free posteriorly (fig. 16, O) ..... *Tor.*
12A. Median portion of lower lip reaching corners of mouth (fig. 16, N); a thick pad in floor of mouth immediately above and behind lower jaw. *Lobocheilus.*
B. Median division of lower lip not reaching corners of mouth (fig. 16, P); no thick pad in floor of mouth ..... 13.
13A. Corner of mouth reaching beyond vertical from anterior margin of eye (fig. 16, Q) ..... *Schismatorhynchus.*
B. Corner of mouth not reaching vertical from anterior margin of eye (fig. 16, R). *Tylognathus.*
14A. Lateral portion of upper lip thick, with many folds (fig. 16, S) .. *Osteochilus.*
B. Lateral portion of upper lip thin, without folds (fig. 16, T) ..... *Dangila.*
15A. Large median pad of lower lip separated posteriorly from chin (fig. 16, U). *Garra.*

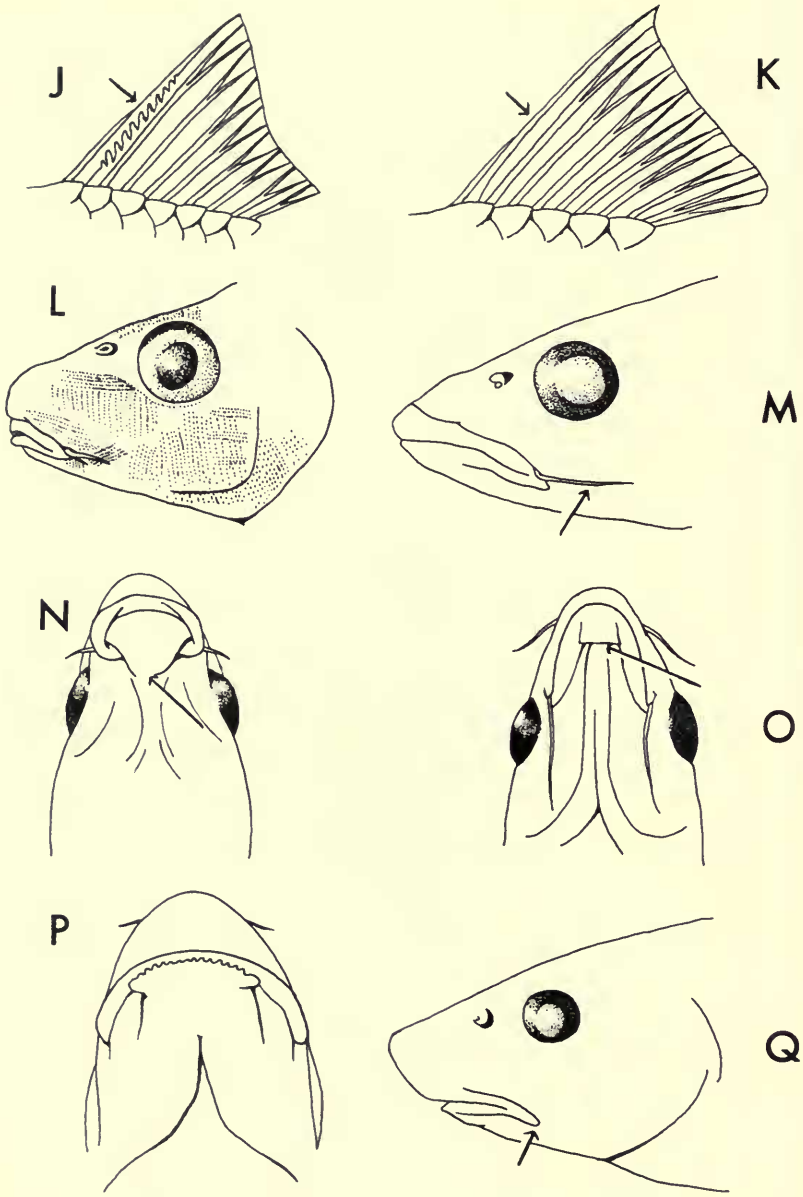

FIG. 16 (*continued*). Key to genera of Cyprinidae.

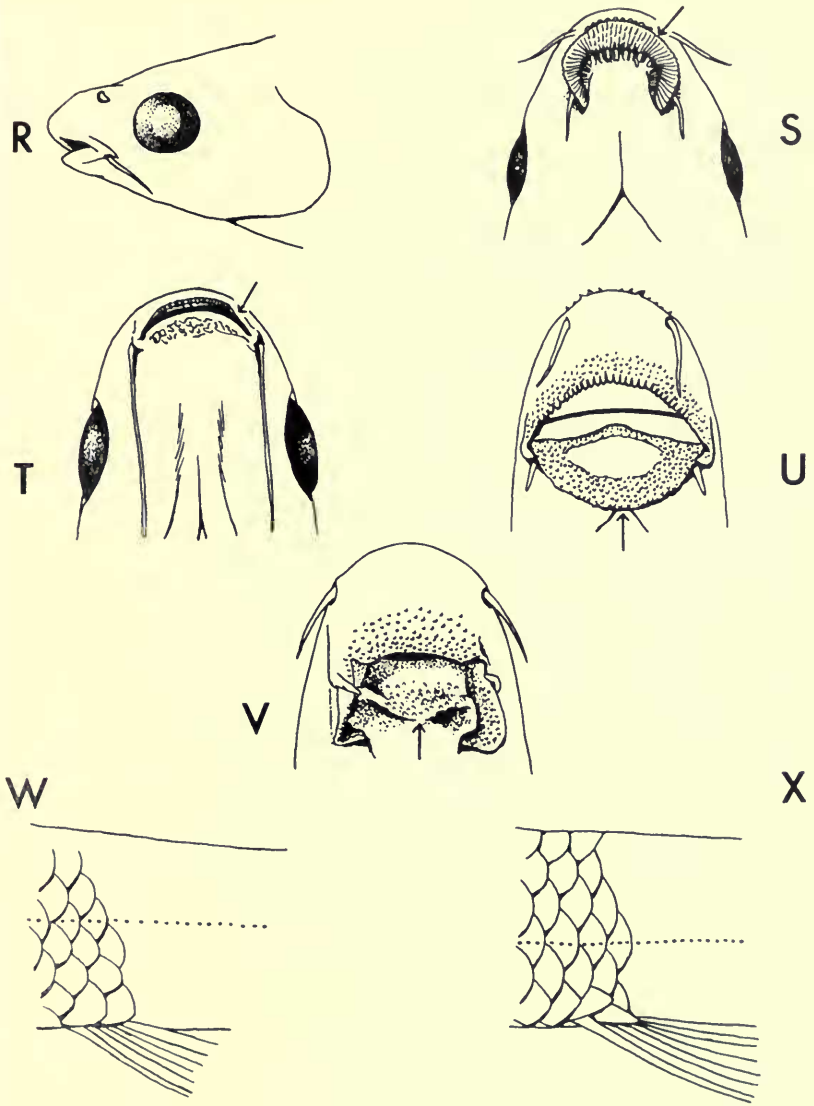

FIG. 16 (*continued*). Key to genera of Cyprinidae.

B. Median part of lower lip not separated posteriorly (fig. 16, V)..... 16.

16A. Four rows of scales between lateral line and insertion of ventral fin (fig. 16, W). *Epalzeorhynchus.*

B. One and one-half to two rows of scales between lateral line and insertion of ventral fin (fig. 16, X)..... *Paracrossochilus.*

Nematabramis Boulenger

The interrelations of the Bornean populations of *Nematabramis* are not clear. However, there seem to be three distinct groups, distinguished as follows:

1A. Body deep, depth 2.5–3.5 times in standard length; 9–11 scales between origins of dorsal and anal; barbels long, usually reaching middle of pectoral fin or beyond; dorsal ii,8–13, rarely below ii,10; anal iii,15–20, rarely below iii,16; range northern and northeastern Borneo.....*everetti* Boulenger.

B. Body more elongate (depth 3.6–4.2); barbels short, reaching no farther than base of pectoral.....2.

2A. Head 3.8–4.1; dorsal ii,8; anal iii,13–16 (mean iii,14.5); 8 scales between origins of dorsal and anal fins; range northwestern Borneo. *alestes borneensis*, new subsp.

B. Head shorter (4.6–4.8); dorsal ii,9–10; anal iii,16–17; range east-central Borneo.....*steindachneri* Popta.

Despite considerable variation in the characters mentioned, the distinctions are statistically significant.

Nematabramis everetti is a much deeper-bodied fish than the others, especially as adults (standard length over 80 mm.). The relative depth becomes noticeably larger with increase in size; 114 *everetti* show the following variation in the ratio of depth to standard length (median in parentheses) with change in size:

Standard length	39.6–49.5	49.6–59.5
Depth	0.287–0.305(0.299)	0.278–0.337(0.300)
Number	4	16
Standard length	59.6–69.5	69.6–79.5
Depth	0.302–0.348(0.330)	0.309–0.370(0.341)
Number	11	32
Standard length	79.6–89.5	89.6–99.5
Depth	0.332–0.383(0.359)	0.333–0.383(0.361)
Number	24	15
Standard length	99.6–100.5	109.6–119.5
Depth	0.358–0.398(0.380)	0.369–0.400(0.383)
Number	8	4

Four specimens of *alestes borneensis* having standard lengths in the range 35–50 mm. have body depths of 0.239–0.258 (median 0.243), four in the range 60–72 mm. have depths of 0.236–0.280 (median 0.259). Depth in the four types of *steindachneri* (total length 127–141 mm., standard length almost certainly over 90 mm.) is 0.243–0.263 (Popta, 1905).

The relative head length shows less variation and serves to separate *a. borneensis* and *steindachneri*. The ratio in the former varies between 0.244 and 0.265, in the latter between 0.208 and 0.217, and in 114 specimens of *everetti* (length 42–116 mm.) between 0.211 and 0.277.

The barbel lengths of *alestes borneensis* may not differ from those of *steindachneri*. Popta notes that in the latter the barbel reaches a short distance beyond the base of the pectoral as it does in most of the specimens of *a. borneensis*. The barbel of *everetti* reaches anywhere from the mid-length of the pectoral to the end of the anal.

Dorsal fin ray counts of *everetti* vary from 8 to 13 branched rays, although of 120 fishes (including Boulenger's types) only five have less than 10 rays (three with 9, and two with 8). All nine *a. borneensis* available have 8 branched dorsals, while the four *steindachneri* types have 9 or 10. Similarly, though the number of branched anal rays of *everetti* varies from 15 to 20 (mean 17.5), only three of 119 have 15 and twenty-one have 16. The nine *a. borneensis* have a range of 13–16 branched dorsals, a mean of only 14.5. The types of *steindachneri* have 16 or 17.

Nematabramis alestes borneensis, new subspecies

Holotype.—Chicago Natural History Museum no. 44791, from Kota Belud, Kota Belud District, North Borneo. Collected February 9, 1950, by P. K. Chin.

Paratypes.—CNHM 44792 (8), collected with the holotype.

Description (data on holotype in parentheses).—Dorsal ii,8 (ii,8) (N=9); pectoral i,11–12 (i,11) (mean i,11.5; N=9); ventral i,5–6 (i,6) (only one has 5 branched rays); anal iii,13–16 (iii,15) (mean iii,14.5; N=9); lateral line scales 34–36 (34) (mean 34.7; N=7); head 0.244–0.265 (0.244) (median 0.255; N=8); depth 0.236–0.280 (0.269) (median 0.248; N=8); predorsal length 0.689–0.729 (0.704) (median 0.702; N=8); eye 0.061 (holotype only); interorbital 0.081 (holotype only); standard length 36.4–71.2 mm. (71.2); total length 44–93 mm. (93).

Dorsal profile rising gradually in straight line from snout to dorsal origin, a slight concavity at nape; ventral profile convex; belly cultrate; top of head flat; orbit immediately below dorsal profile, subequal to snout; mouth oblique, terminal; maxilla ending below front border of orbit; mandible with a symphyseal knob; a pair of maxillary barbels, reaching base of pectoral fin or slightly

beyond; gill opening extending forward to below posterior border of orbit; pharyngeal teeth 5+4.

Pectoral inserted low on side, pointed, longer than head, reaching above ventral; ventral short, failing to reach anus; dorsal origin behind that of anal, margin feebly concave, longest ray equal to head minus snout; anal margin concave, longest ray equal to longest dorsal ray.

Lateral line sharply decurved; predorsal scales 23–24; transverse scales from lateral line to origin of dorsal 6, to insertion of ventral 1; transverse series between origins of dorsal and anal 8; circumpeduncular scales 12.

Color in alcohol reddish brown; a mid-lateral black stripe from gill opening to base of caudal, widening posteriorly; short vertical black bars on some lateral scales, varying in number and position; a mid-dorsal black stripe well developed from occiput to dorsal origin, obsolete over caudal peduncle; fins lightly peppered with dark chromatophores, the vertical fins dusky distally.

Remarks.—This form differs from *alestes alestes* Seale and Bean (type locality Mindanao, Philippine Islands) in its longer barbel. The barbel of the Philippine form never reaches the end of the opercle. In eight specimens from the Calamianes Islands north of Palawan, the barbel ends between the preopercle and the last third of the opercle. This observation agrees with statements of Seale and Bean (1907), Herre (1924), and Fowler (1941). The Philippine form usually lacks the short, black lateral bars invariably occurring in the Bornean sample. Otherwise the two subspecies are very similar. They are compared in other respects in the following table. Means and their standard errors or medians are in parentheses.

	alestes alestes	*alestes borneensis*
Number of specimens	8	9
Standard length (mm.)	49.2–81.7	36.4–71.2
Dorsal fin	ii,8	ii,8
Pectoral fin	i,11–12 (i,11.2±0.2)	i,11–12 (i,11.6±0.2)
Anal fin	iii,13–15 (iii,14.0±0.2)	iii,13–16 (iii,14.4±0.3)
Lateral line scales	34–36 (35.0±0.3)	34–36 (34.7±0.3)
Head	0.246–0.272 (0.258)	0.244–0.265 (0.255)
Depth	0.245–0.289 (0.263)	0.236–0.280 (0.248)
Predorsal length	0.694–0.729 (0.704)	0.689–0.729 (0.702)

Comparison with other species has been made above (p. 46).

Locality.—Kota Belud District, Kota Belud (9).

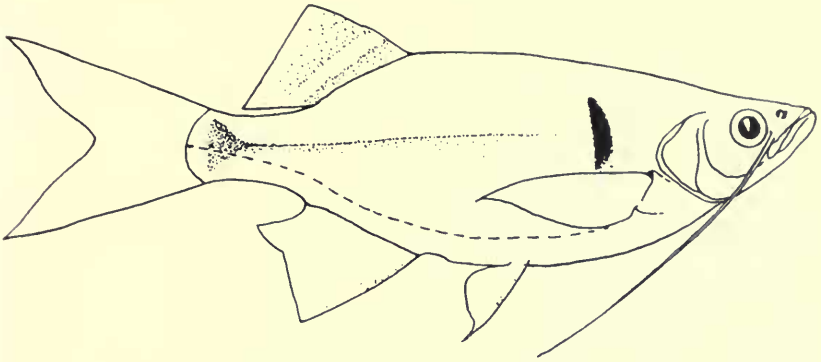

FIG. 17. *Nematabramis everetti.*

Nematabramis everetti Boulenger. Figure 17.

Nematabramis everetti Boulenger, 1894, Ann. Mag. Nat. Hist., (6), **13**: 250—Bongon and Marabah, North Borneo, and Baram River, Sarawak; Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 46; Fowler, 1941, Bull. U. S. Nat. Mus., no. 100, **13**: 817, fig. 30.

Nematabramis steindachneri (not of Popta) Herre, 1933, Jour. Pan-Pacific Res. Inst., 8, no. 4, p. 3.

Dorsal ii,8–13 (mean ii,11.4; N=120); pectoral i,11–14 (mean i,12.0; N=82); ventral i,5 (i,6 a rare variation); anal ii–iii,15–20 (mean branched rays 17.5; N=119); lateral line scales 30–36 (mean 32.8; N=77); transverse scales between origins of dorsal and anal 9–11; gill rakers 0–2+6–9, total 7–11; head 0.211–0.277 (median 0.250; N=114); depth 0.278–0.400, increasing with increase in standard length; depth of specimens over 80 mm. 0.332–0.400 (median 0.364; N=51); predorsal length 0.625–0.699; standard length 10.2–116.5; maximum total length 157 mm.

Mature males had small tubercles scattered over the body and on the rays of dorsal, anal, and caudal fins. These tubercles formed a thick band on the lower jaw. Some large females had a few on the lower jaw but none on the fins and body.

Data on Boulenger's five specimens (courtesy of Dr. E. Trewavas, British Museum) are included in the dorsal and anal calculations above. Otherwise only fishes from eastern North Borneo were used. The latter group differs from the typical material in depth. According to the measurements supplied by Dr. Trewavas, two of Boulenger's specimens, those from Bongon (standard length 85–90 mm.), have depths of 0.322–0.341, thus falling within the range for their size

class given above; but a third type (71 mm.), from Marabah, North Borneo, has a depth of 0.267 and lies outside of the total range of variation of specimens 49 mm. and over, from eastern North Borneo. The remaining two types (32 and 82 mm.), from the Baram District of northern Sarawak, have depths of 0.234 and 0.292 respectively. The smaller of these lies outside the limits of variation for the eastern series. The larger of the two has a smaller ratio than eastern fishes of its size range (0.332–0.383).

The Bongon types are closer to the eastern series in dorsal and anal counts (ii,11–12 and iii,17–18, respectively) than are the Marabah and Baram fishes (ii,8–9 and iii,15–17). Both in depth and counts the Marabah and Baram specimens are at least as similar to *alestes borneensis* as to the Bongon types and the eastern fishes we have identified as *everetti*.

A series of fishes from Sandakan (CNHM 23392–403), identified by Herre (1933) as *steindachneri*, are conspecific with those listed here as *everetti*. Herre's material differs radically from Popta's description (1905) of *steindachneri* in the characters used in the key (p. 46). The barbels are longer in specimens from the middle Kinabatangan basin (Deramakot), reaching at least as far as the tip of the pectoral but usually to between the origin and the end of the anal; in all other specimens we have seen the barbel does not reach beyond the tip of the pectoral and usually does not reach the middle of the pectoral.

Nematabramis everetti is the most abundant cyprinid in the small streams of eastern North Borneo, over silt, gravel, and rock bottoms. It swims actively near the surface and feeds largely on terrestrial insects that fall into the water (Inger, 1955).

Local names.—"Lallang" or "Gepeng" (Malay); "Dumpis" (Dusun). These names are used for all species of the genus *Nematabramis*.

Localities.—Beaufort District, Marabah (Boulenger, 1894); Kinabatangan District, Sungei Gaja (392), unnamed tributary of Sungei Kretam Kechil (87), Sungei Kuntong near Pintasan (15), Danau Bukit Garam (3), Lamag (2), Sungei Pinang (198), unnamed stream about one mile above Sungei Tabalin Besar (50), Deramakot (311); Kudat District, Bongon (Boulenger, 1894); Lahad Datu District, Sungei Edam (7); Ranau District, Ranau (8); Sandakan District, Sandakan and vicinity (133), tributary of Sungei Sapagaya (32), Sepilok Forest Reserve (39); Tawau District, Kalabakan, Sungei Tawan (1445), Sungei Brantian (14), Selimpopon and Tawau Rivers (Fowler, 1941).

Chela Hamilton

According to both Smith (1945) and Silas (1958) the genus *Chela* is distinguished from *Oxygaster* van Hasselt by two characters. In *Chela* the predorsal scales do not reach the interorbital space and it lacks a symphyseal knob or hook, whereas *Oxygaster* has scales in the interorbital space and has a symphyseal knob. We have a large series of the species *Chela anomalura* (van Hasselt) from Sarawak in which the predorsal scales fail to reach the interorbital space but in which a symphyseal knob is present. This series, therefore, shares characters of both genera, and we think it a mistake to recognize two genera.

Chela oxygastroides (Bleeker). Figure 18.

Leuciscus oxygastroides Bleeker, 1852, Nat. Tijds. Ned. Indië, **3**: 431.

Chela oxygastroides Bleeker, 1863, Atlas Ichth., **3**: 135; Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 51, fig. 22.

Chela megalolepis Günther, 1868, Cat. Brit. Mus., **7**: 337.

Oxygaster oxygastroides Smith, 1945, Bull. U. S. Nat. Mus., no. 188, p. 76.

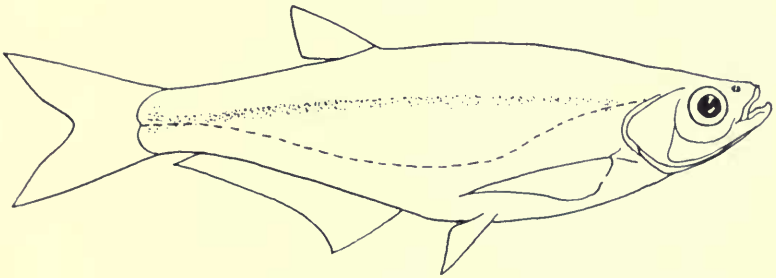

FIG. 18. *Chela oxygastroides.*

Dorsal ii,7–8 (only 2 of 12 specimens had 8 branched rays); pectoral i,11–13 (mean i,12.2; N=12); ventral i,6 (N=12); anal iii,30–33 (mean iii,31.6; N=12); lateral line scales 39–43 (mean 40.7; N=11); gill rakers 2–3+10–11; pharyngeal teeth (right side) 2–4–4; head 0.192–0.228 (median 0.216; N=11); depth 0.252–0.286 (median 0.267; N=11); snout 0.038–0.053 (median 0.049; N=11); eye 0.065–0.075 (median 0.071; N=11); interorbital 0.062–0.069 (median 0.065; N=11); standard length 67.4–93.7 mm.; total length 87.2–119.0 mm.

Color in alcohol silvery with a dark longitudinal streak midlaterally.

The three stomachs examined contained fragments of insects.

Localities.—Tawau District, Kalabakan River near Sungei Maga (30), Sungei Tawan (2).

Rasbora Bleeker

People of North Borneo apply local names to the fishes of this genus without distinguishing between species. The names used are: "Seluang" or "Putain" (Malay); "Buntong" (Keningau Dusun); "Londoi" (Dusun), and "Buntod" (Orang Sungei).

KEY TO SPECIES FROM NORTH BORNEO

1A. Tip of pectoral fin reaching ventral fin (fig. 19, A) ..... 2.
B. Tip of pectoral fin not reaching ventral fin ..... 4.
2A. A black longitudinal stripe from tip of snout to end of middle caudal rays (fig. 19, B) ..... *einthoveni.*
B. Black longitudinal stripe if present never reaching tip of snout ..... 3.
3A. A round or rectangular black spot in center of body and another at base of caudal ..... *elegans.*
B. A mid-lateral dark stripe usually present; never with an isolated black spot in center of body ..... *myersi.*
4A. Tips of caudal lobes black ..... 5.
B. Tips of caudal lobes not black, or entire caudal fin dusky ..... 6.
5A. Supra-anal black streak usually wider anteriorly than its distance from base of anal (fig. 19, C); dorsal-hypural distance (measured in mid-lateral line) equals dorsal-nostril distance ..... *sumatrana.*
B. Supra-anal black streak narrower than its distance from base of anal (fig. 19, D); dorsal-hypural distance shorter than dorsal-nostril distance ..... sp.
6A. Lateral line incomplete ..... *semilineata.*
B. Lateral line complete to base of caudal ..... 7.
7A. Two and one-half scales between lateral line and mid-ventral line in front of ventral fin; lower edge of caudal peduncle black ..... *argyrotaenia.*
B. Three and one-half scales between lateral line and mid-ventral line in front of ventral fin; lower edge of caudal peduncle not black ..... 8.
8A. Usually 12 circumpeduncular scales; intense black stripe in posterior half of body only ..... *rutteni.*
B. Usually 14 circumpeduncular scales; lateral stripe usually intensely black from opercle to base of caudal ..... *hubbsi.*

Rasbora einthoveni (Bleeker). Figure 19, B.

Leuciscus einthovenii Bleeker, 1851, Nat. Tijds. Ned. Indië, **2**: 434—Sambas, Borneo.

Rasbora einthovenii Bleeker, 1859, Act. Soc. Indo-Neerl., **16**: 154; Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 72; Hardenberg, 1936, Treubia, **15**: 235; Brittan, 1954, Rev. Fish Genus *Rasbora*, p. 149, fig. 35.

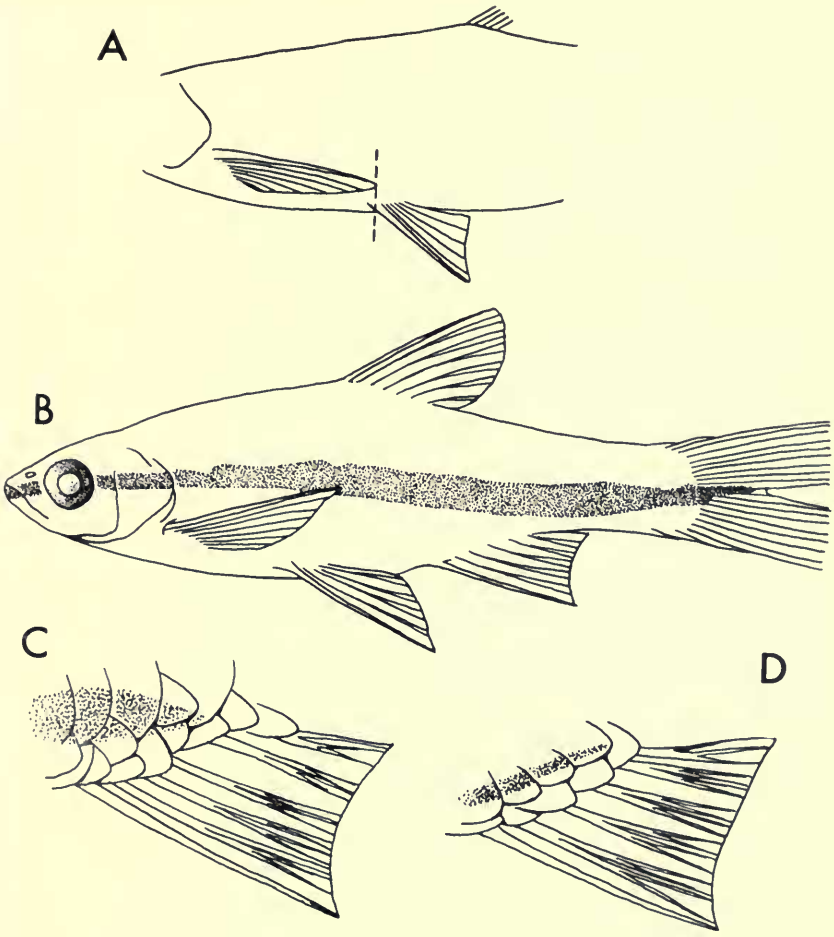

FIG. 19. Key to species of *Rasbora*.

Dorsal ii,7 (N=10); pectoral i,12–13 (mean 12.7; N=10); ventral i,7 (N=10); anal iii,5 (N=10); lateral line scales 26–30 (mean 27.0; N=9); transverse scales 4½/1/2½; predorsal scales 11–13 (mean 12.2; N=9); circumpeduncular scales 12 (N=7); gill rakers 0–1+7, total 7–8 (mean total 7.7; N=3); head 0.252–0.279 (median 0.266; N=10); depth 0.241–0.271 (median 0.259; N=10); snout 0.056–0.072 (median 0.062; N=10); eye 0.084–0.095 (median 0.091; N=10); interorbital 0.108–0.121 (median 0.114; N=10); height-length ratio of caudal peduncle 0.528–0.628 (median 0.597; N=8); standard length 31.7–40.2 mm.

Scales in upper half of body densely pigmented; scales in lower third of body with a few fine dots; a conspicuous, broad, black stripe from tip of snout to end of middle caudal rays, the stripe just below mid-lateral axis; pectorals, ventrals, dorsal, and anal each with a dusky longitudinal streak; caudal dusky near upper and lower margins. In life the lateral stripe is iridescent gun-metal blue.

This species lives in small, mud-bottomed streams.

Localities.—Sandakan District, Sungei Sibuga (51), Sungei Gum Gum (5).

Rasbora elegans Volz. Figure 20.

Rasbora elegans Volz, 1903, Zool. Jahrb., Syst., **19**: 402, pl. 26, fig. 4; Duncker, 1904, Mitt. Nat. Mus. Hamburg, **21**: 182; Brittan, 1954, Rev. Fish Genus *Rasbora*, p. 64, fig. 9.

Rasbora lateristriata var. *elegans* Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 78.

Dorsal ii,7; pectoral i,14; ventral i,7, i; anal iii,5; lateral line scales 26; transverse scales 4½/1/2½; predorsal scales 11; circumpeduncular scales 12; gill rakers 2+8; head 0.252; depth 0.290; snout 0.053; eye 0.079; interorbital 0.122; standard length 69.6 mm.; total length 92.7 mm.

Color in alcohol dusky brown above, lighter below; no mid-lateral stripe; a round or rectangular black spot mid-laterally between

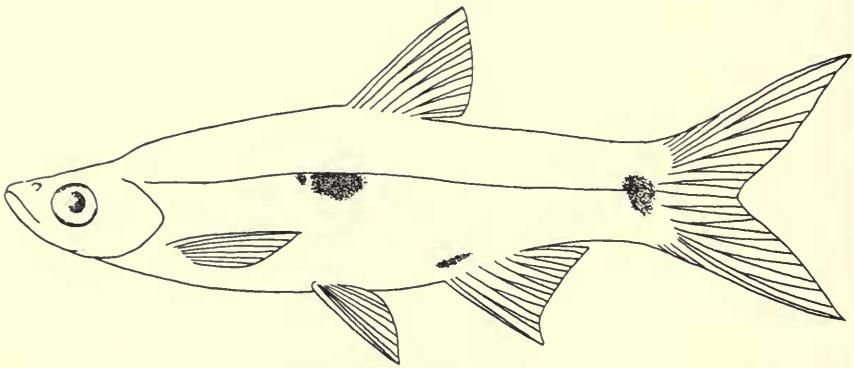

FIG. 20. *Rasbora elegans.*

origins of dorsal and ventral fins; a large round black spot at base of caudal fin; caudal rays dusky, darker near tips; dorsal and anal fins dusky, though not as dark as caudal; other fins colorless.

Locality.—Tawau District, tributary of Sungei Brantian (1).

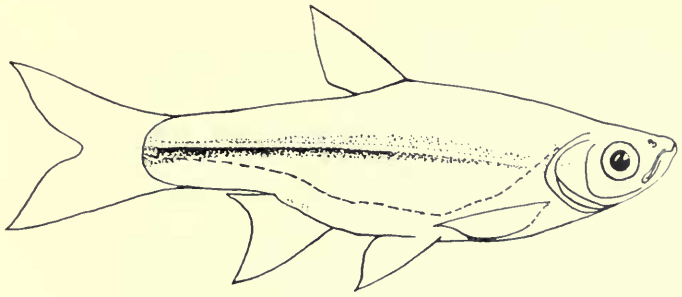

FIG. 21. *Rasbora myersi.*

Rasbora myersi Brittan. Figure 21.

Rasbora myersi Brittan, 1954, Rev. Fish Genus *Rasbora*, p. 117, fig. 25—Putus Sibau, Kapuas River, Indonesian Borneo.

Rasbora argyrotaenia (part) Brittan, op. cit., p. 107.

Dorsal ii,6–7 (mean ii,6.8; N=12); pectoral i,12–13 (mean i,12.5; N=12); ventral i,6–7,i (only 1 out of 13 specimens had i,6,i); anal iii,5 (N=12); lateral line scales 27–31 (mean 28.7; N=14); transverse scales 4½/1/2½–3½; predorsal scales 11–13 (mean 12.1; N=14); circumpeduncular scales 12–14 (mean 13.6; N=15); gill rakers 3–6+10–15, total 14–21 (mean total 18.7; N=15); head 0.238–0.269 (median 0.261; N=15); depth 0.244–0.296 (median 0.264; N=15); snout 0.047–0.075 (median 0.061; N=12); eye 0.077–0.102 (median 0.086; N=12); interorbital 0.092–0.108 (median 0.098; N=12); length of pectoral 0.227–0.261 (median 0.248; N=15); height-length ratio of caudal peduncle 0.573–0.679 (median 0.625; N=14); predorsal length 0.536–0.603 (median 0.565; N=14); standard length 26.2–71.2 mm.; total length 35.2–93.9 mm.

Pectoral fin reaching base of ventral or slightly beyond; lateral line rising abruptly before ventral fin; gill rakers relatively long (fig. 22, A).

Scales above mid-lateral streak dusky, usually those below streak without pigment except for a few scales anteriorly; supra-anal dark streak absent or present as a thin line; a dark longitudinal stripe below axial streak anteriorly from opercle to base of caudal, often obscure anteriorly; fins without pigment.

All of the specimens we have examined from North Borneo were collected in turbid water; 75 were collected in oxbow lakes, 235 in the mouths of tributaries of the Kinabatangan and 150 in the Kinabatangan itself.

The stomachs of six contained fragments of ants.

Females with enlarged ova measured 52.4–71.2 mm.

Localities.—Kinabatangan District, Abai (1), Bukit Garam (23), small stream one mile above Sungei Tabalin Besar (231), Deramakot

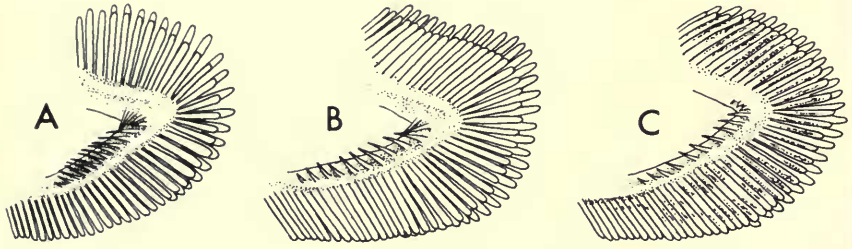

FIG. 22. Gill rakers of (A) *Rasbora myersi*, (B) *R. sumatrana*, and (C) *R. argyrotaenia;* drawn to same scale.

(4), Kinabatangan River below mouth of Sungei Malubok (150), Danau Duadan (8), Mintak (5), Danau Bilit (31).

Rasbora sumatrana (Bleeker). Figure 23.

Leuciscus sumatranus Bleeker, 1852, Nat. Tijds. Ned. Indië, **3**: 601—Solok, Sumatra.

Rasbora sumatrana Bleeker, 1859, Act. Soc. Indo-Neerl., **16**: 154; Brittan, 1954, Rev. Fish Genus *Rasbora*, p. 53, figs. 6–7.

Rasbora trilineata (not of Steindachner) Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 67 (part); Herre, 1933, Jour. Pan-Pacific Res. Inst., **8**, no. 4, p. 1; Fowler, 1941, Bull. U. S. Nat. Mus., no. 100, **13**: 813.

Dorsal ii,6–7 (only one out of 50 specimens had 6 branched rays); pectoral 1,12–15 (mean i,12.6; N=58); ventral i,6–7,i or i,8 (mean branched rays 7.6; N=57); anal iii,5–6 (only one out of 52 specimens had 6 branched rays); lateral line scales 24–30 (mean 27.6; N=59); transverse scales 4½/1/2½; predorsal scales 10–12 (mean 11.5; N=20); circumpeduncular scales 12–14 (mean 12.1; N=55); gill rakers (fig. 22, B) 2–3+8–12, total 10–15 (mean total 11.2; N=20); head 0.229–0.284 (median 0.265; N=60); depth 0.237–0.313 (median 0.260; N=60); snout 0.058–0.081 (median 0.068; N=16); eye 0.062–0.094 (median 0.073; N=16); interorbital 0.095–0.117 (median 0.104; N=16); length of pectoral 0.194–0.242 (median 0.224; N=19); height-length ratio of caudal peduncle 0.582–0.662 (median 0.616; N=18); predorsal length 0.521–0.567 (median 0.533; N=10); standard length 20.5–111.9 mm.; total length 34.5–145.0 mm.

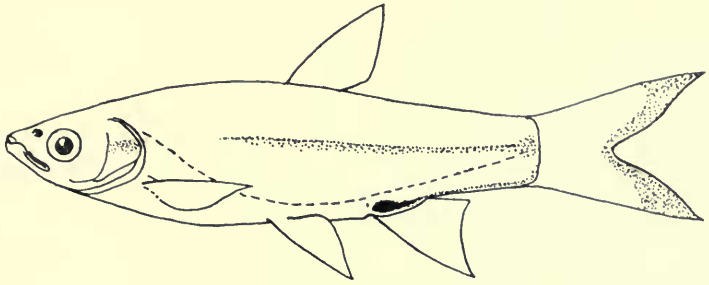

FIG. 23. *Rasbora sumatrana.*

Color in life silvery, darker above; a black mid-lateral line extending from behind operculum to base of caudal; a black mid-dorsal line, most pronounced behind dorsal; a wide black streak at base of anal, drawn out posteriorly and running in mid-ventral line behind anal; distal third or more of caudal lobes black; no black on other fins; caudal orange or yellow proximally; dorsal yellow; ventrals yellow or clear; pectorals without pigment; in alcohol no orange or yellow on fins.

Some mature males (72–87 mm.) had small whitish tubercles on the top of the head. Females with enlarged ova measured 62.4–93.8 mm.

Most of the approximately 450 fishes we have examined were caught in small clear streams having silty or gravelly bottoms. In the quiet pools of these streams, *sumatrana* can easily be recognized by the black-tipped caudal fin as it swims in small schools near the surface. Four specimens were caught with a cast net in the muddy Kinabatangan River near the bank.

The food consists primarily of terrestrial insects that fall into the small forest streams (Inger, 1955).

Localities.—Jesselton District, Menggatal (2); Kinabatangan District, Sungei Gaja (207), unnamed tributary of Sungei Kretam Kechil (73), Deramakot (96); Lahad Datu District, Sungei Edam (Brittan, 1954); Sandakan District, Sungei Gum Gum, Sungei Kabili, Sandakan (Brittan, op. cit.), tributary of Sungei Sapagaya (31), Sepilok Forest Reserve (34); Semporna District, Sungei Mapat (Brittan, op. cit.); Tawau District, Selimpopon River, Sungei Tawau (Fowler, 1941), Sungei Balung, Sungei Kinabutan (Brittan, op. cit.), Kalabakan, Sungei Tawan (18), Sungei Maga (8), Sungei Brantian (4); Tuaran District, Kiulu (1).

Rasbora sp.

These specimens differ slightly from *sumatrana*. They have a shorter and deeper caudal peduncle and as a result the dorsal-hypural distance is shorter than the dorsal-nostril distance. They also differ from *sumatrana* in having a narrower supra-anal black streak and less black pigment on the caudal lobes. These specimens were collected in one of the few stations at which we did not collect *sumatrana*. In view of the complexity of this genus we are refraining from naming this form until additional material and information are collected.

Dorsal ii,7; pectoral i,12–14 (mean i,13.1; N=7); ventral i,7,i–i,8 (mean branched rays 7.3; N=6); anal iii,5; lateral line scales 25–28 (mean 26.3; N=8); transverse scales 4½/1/2½; predorsal scales 12 (N=8); circumpeduncular scales 12; gill rakers 1–2+8–10, total 10–12 (mean total 10.5; N=6); head 0.252–0.279 (median 0.265; N=9); depth 0.285–0.316 (median 0.295; N=9); snout 0.061–0.069 (median 0.062; N=77); eye 0.064–0.090 (median 0.078; N=7); interorbital 0.104–0.122 (median 0.111; N=7); length of pectoral 0.229–0.240 (median 0.233; N=9); height-length ratio of caudal peduncle 0.617–0.783 (median 0.698; N=9); predorsal length 0.529–0.563 (median 0.545; N=9); standard length 28.8–69.0 mm.; total length 38.3–92.2 mm.

Scales above mid-lateral axis densely pigmented, those immediately below with dark vertical streaks; supra-anal streak thin; a dark longitudinal stripe from opercle to base of caudal, the stripe running in mid-lateral axis except anteriorly; tips of caudal rays black; other fins colorless.

Three females with enlarged ova measured 59.7–69.0 mm.

Our specimens were collected in a small muddy tributary of the Kinabatangan.

Locality.—Kinabatangan District, Deramakot (11).

Rasbora semilineata Weber and de Beaufort

Rasbora semilineata Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 80—Wain River, Borneo; Brittan, 1954, Rev. Fish Genus *Rasbora*, p. 184, fig. 43.

Dorsal ii,6–7 (only 1 out of 8 had 6 branched rays); pectoral i,12–13 (only 1 out of 8 had 13 branched rays); ventral i,7 (N=8); anal iii,5 (N=8); lateral line scales 25–29; perforated scales 4–8 (mean 6.7; N=8); transverse scales 4½/1/2½; predorsal scales 12 (N=9); circumpeduncular scales 12 (N=9); gill rakers 2–3+9, total

11–12 (mean 11.6; N=6); head 0.278–0.310 (median 0.289; N=9); depth 0.285–0.319 (median 0.305; N=9); snout 0.048–0.065 (median 0.060; N=9); eye 0.085–0.104 (median 0.092; N=9); interorbital 0.109–0.118 (median 0.112; N=9); height-length ratio of caudal peduncle 0.566–0.685 (median 0.612; N=9); predorsal length 0.523–0.581 (median 0.545; N=9); standard length 25.8–37.6 mm.; total length 32.8–49.0 mm.

Color in alcohol dusky on upper half of body, lighter below; a thin dark axial streak; a round dark spot at base of caudal; a thin supra-anal dark streak continued along mid-ventral line of caudal peduncle; fins colorless.

Locality.—Kinabatangan District, Tambisan Island (52).

Rasbora argyrotaenia (Bleeker). Figure 24.

Leuciscus argyrotaenia Bleeker, 1850, Verh. Bat. Gen., **23**: 21—Java.

Rasbora argyrotaenia Bleeker, 1859, Act. Soc. Indo-Neerl., **16**: 154; Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 61 (part); Hardenberg, 1936, Treubia, **15**: 235; Brittan, 1954, Rev. Fish Genus *Rasbora*, p. 107, fig. 22 (part).

Dorsal ii,7; pectoral i,13–14; ventral i,7–8; anal iii,5; lateral line scales 27–29; transverse scales 4½/1/2½; predorsal scales 11; circumpeduncular scales 14; gill rakers (fig. 22, C) 2–3+7–8, total 10–11; head 0.241–0.261; depth 0.219–0.232; snout 0.067–0.078; eye 0.074–0.083; interorbital 0.085–0.094; height-length ratio of caudal

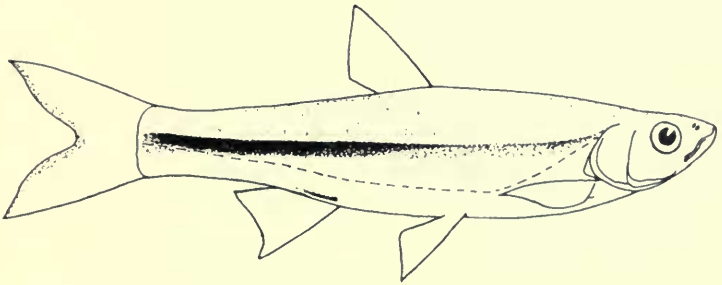

FIG. 24. *Rasbora argyrotaenia.*

peduncle 0.533–0.583; length of pectoral 0.207–0.227; predorsal length 0.525–0.553; standard length 52.4–85.7 mm.; total length 71.4–115.0 mm.

Pectoral separated from ventral by one or two scales.

Color in alcohol dusky above, lighter below; scales immediately below mid-lateral axis with dark vertical streaks; dark longitudinal

stripe in mid-lateral axis from opercle to base of caudal; a narrow supra-anal black streak; fins colorless, except for a few melanophores on pectoral rays.

We have examined all of the North Bornean specimens listed by Brittan (1954, p. 109). Only those from the Tempasuk River are *argyrotaenia*. The remainder are *myersi* or are unidentifiable (SU 40104, Kabili River).

In North Borneo this species has been found only in clear water over gravel bottoms.

Locality.—Kota Belud District, Tempasuk River (3).

Rasbora rutteni Weber and de Beaufort

Rasbora rutteni Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 68, fig. 26—Sungei Wain, Bontang, Borneo; Brittan, 1954, Rev. Fish Genus *Rasbora*, p. 94, fig. 18.

Dorsal ii,7; pectoral i,12–13 (only 1 out of 6 had 13 branched rays); ventral i,6,i (N=6); anal iii,5; lateral line scales 24–26 (mean 25.1; N=6); transverse scales 4½/1/3½; predorsal scales 10–11 (only 1 out of 5 had 10 scales); circumpeduncular scales 12 (N=4) or 14 (N=2); gill rakers 1–2+6–7, total 7–8 (mean total 7.6; N=5); head 0.234–0.276 (median 0.252; N=6); depth 0.264–0.306 (median 0.281; N=6); snout 0.058–0.078 (median 0.065; N=6); eye 0.077–0.086 (median 0.081; N=6); interorbital 0.093–0.106 (median 0.099; N=6); height-length ratio of caudal peduncle 0.424–0.628 (median 0.567; N=6); length of pectoral 0.214–0.231 (median 0.221; N=6); predorsal length 0.490–0.530 (median 0.522; N=6); standard length 31.5–42.6 mm.; total length 41.4–55.5 mm.

Scales above mid-lateral axis dusky, those below without pigment except in anterior half of body; a broad mid-lateral black stripe, intensely black in posterior half of body only, usually dusky in anterior half of body; a narrow black supra-anal streak, not continued on lower edge of caudal peduncle; fins colorless.

Both sexes have small whitish tubercles on lower jaw and tip of snout. Four females with enlarged ova measured 37.3–42.6 mm.

Our specimens were caught in a small, clear forest stream having a mixed sand and gravel bottom.

Locality.—Tawau District, Kalabakan, Sungei Tawan (8).

Rasbora hubbsi Brittan

Rasbora hubbsi Brittan, 1954, Rev. Fish Genus *Rasbora*, p. 105, fig. 21—Lahad Datu River, North Borneo.

Dorsal ii,7 (N=14); pectoral i,11–13 (mean i,12.1; N=12); ventral i,6,i (N=15); anal iii,5 (N=14); lateral line scales 25–28 (mean 27.2; N=17); transverse scales 4½/1/3½; predorsal scales 10–12 (mean 11.1; N=18); circumpeduncular scales 12–14 (only 1 out of 20 had 12 scales); gill rakers 1–2+6–8, total 7–10 (mean total 8.4; N=16); head 0.230–0.272 (median 0.257; N=23); depth 0.221–0.285 (median 0.254; N=22); snout 0.047–0.065 (median 0.057; N=10); eye 0.076–0.094 (median 0.087; N=10); interorbital 0.094–0.108 (median 0.102; N=10); height-length ratio of caudal peduncle 0.450–0.638 (median 0.500; N=15); length of pectoral 0.179–0.224 (median 0.205; N=15); predorsal length 0.491–0.564 (median 0.533; N=15); standard length 26.8–39.0 mm.; total length 35.0–51.7 mm.

In alcohol, scales above mid-lateral axis dusky, those below without pigment except in anterior half of body; a narrow black longitudinal stripe running from opercle to base of caudal, below mid-lateral axis in anterior half of body; a thin supra-anal streak present or absent, if present not continuing along lower edge of caudal peduncle. In life pale golden above, silvery below, base of caudal orange.

Some adults (33–39 mm.) of both sexes had small whitish tubercles on the top of the head, the snout, and the lower jaw. Enlarged ova were found in females measuring 32–42 mm.

Except for 14 caught in the Kinabatangan River, the 132 fishes we examined were collected in small forest streams. The 14 from the Kinabatangan and an additional 21 were living in turbid water over mud bottoms. The remainder were found in clear water over sand or gravel bottoms.

Four digestive tracts contained fragments of insects.

Localities.—Kinabatangan District, Deramakot (14); Lahad Datu District, Sungei Edam (Brittan, 1954); Tawau District, Kalabakan, Sungei Tawan (51), Sungei Maga (27), Sungei Marikut (21), Sungei Brantian (18), Sungei Balung (10).

Luciosoma Bleeker

KEY TO SPECIES FROM BORNEO

1A. Barbels rudimentary or absent, never more than one-half eye diameter. *trinema* (Bleeker).

B. Rostral barbels equal to eye diameter or more. . . . . 2.

2A. Median caudal rays unmarked; each caudal lobe with a submarginal black band; usually 12 scales around caudal peduncle. . . . . *setigerum* Valenciennes.

B. A black median caudal stripe; submarginal bands of caudal present or absent; 14 scales around caudal peduncle. . . . . *pellegrini* Popta.

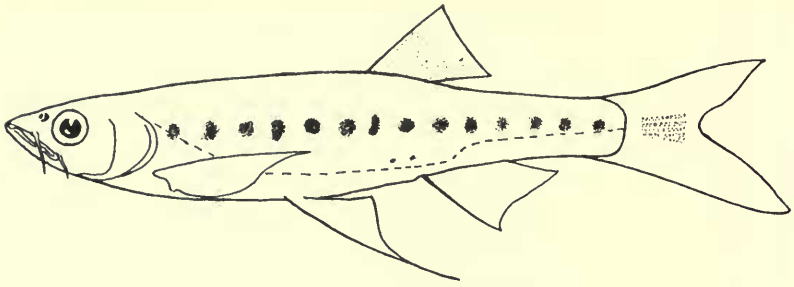

FIG. 25. *Luciosoma pellegrini.*

Luciosoma pellegrini Popta. Figure 25.

Luciosoma pellegrini Popta, 1905, Notes Leyden Mus., **25**: 178—Bo River, Borneo.

Luciosoma spilopleura Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 89 (part).

Dorsal ii,7 (N=23); pectoral i,13–14 (mean i,13.1; N=15); ventral i,7–i,7,i; anal iii,6–7 (mean iii,6.8; N=24); lateral line scales 36–45 (mean 40.2; N=12); predorsals 20–22 (mean 21.1; N=20); gill rakers 2–3+8–11, total 10–14 (mean of total 10.9; N=18); head 0.223–0.294 (median 0.251; N=24); depth 0.198–0.234 (median 0.215; N=22); snout 0.057–0.081 (median 0.066; N=12); eye 0.058–0.089 (median 0.071; N=12); interorbital 0.076–0.098 (median 0.085; N=12); standard length 20.5–135.0 mm.; total length 27.5–169.5 mm.

Popta (1906) distinguished *pellegrini* from *spilopleura* Bleeker on the basis of coloration and the length of the ventral fins. In the former the basal two-thirds of the caudal fin is blackish, the pigment being pronounced on the median rays. By contrast three distinct black caudal bands are present in *spilopleura* (type locality Sumatra), one median and two submarginal ones. Black pigment is restricted to the median caudal rays of our fishes.

The first ventral ray of *pellegrini* is elongated, extending far beyond the branched rays and reaching at least to the second or third branched anal ray. In one specimen (125.5 mm.) the ventral reached the posterior end of the anal. The ventral rays of *spilopleura* end before the anal (type of *spilopleura*, 108 mm., examined by Dr. Trewavas, British Museum). Weber and de Beaufort (1916) expressed the opinion that this difference between the two forms is a matter of age difference. However, all specimens at hand, 30 to 135 mm., have ventral rays overlapping the anal.

In juveniles (ca. 30 mm.) the barbels are very short, usually less than the width of the pupil. Although it varies considerably, the rostral barbel of adults is longer than the eye diameter.

Adult males (98.6–125.5 mm.) had a narrow band of close-set horny tubercles on the tip of the snout and the lower jaw.

The digestive tracts were examined in 7 specimens, 5 from muddy streams and 2 from clear hill streams. All contained fragments of terrestrial insects (mostly ants); one fish (ca. 20 mm.) was found in the stomach of a 63 mm. specimen.

This fish lives in the Kinabatangan River and in tributaries having either gravel or mud bottoms.

Local name.—"Seluang" (Orang Sungei).

Localities.— Kinabatangan District, Danau Bilit (3), Danau Bukit Garam (8), Lamag (2), Mintak Camp, Kinabatangan River (1), unnamed stream one mile above Sungei Tabalin Besar (1), Deramakot (274).

Leptobarbus Bleeker

The black, mid-lateral stripe of *melanotaenia* distinguishes it from *hosii*, the other form living in North Borneo.

Both species are referred to locally as "Belanak Sungei," "Lolau," and "Makalou" (Orang Sungei).

Leptobarbus hosii (Regan). Figure 26.

Barbus hosii Regan, 1906, Ann. Mag. Nat. Hist., (7), **18**: 66—Baram District, Sarawak.

Leptobarbus hosii Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 98.

Dorsal iii,7; pectoral i,13–16 (mean i,14.5; N=4); ventral i,8; anal iii,5; lateral line scales 34–36 (mean 35.0; N=4); transverse scales 5½/1/4½; predorsal scales 13; gill rakers 5–6+9–11, total 14–17 (mean total 15.5; N=4); head 0.253–0.287 (median 0.279; N=4); depth 0.258–0.308 (median 0.272; N=4); eye 0.048–0.058 (median 0.053; N=4); interorbital 0.130–0.142 (median 0.135; N=4); standard length 125.5–150 mm.

Color in life silvery; fins tinged with red.

These fishes differ from *L. hoeveni* not only in the number of scales between the lateral line and the origin of the dorsal (4½ in *hoeveni*, 5½ in *hosii*), but also in the size of the eye (0.070–0.084 in five *hoeveni*, standard lengths 80.9–162 mm.) and in the length of the maxillary barbel. The barbel in the five *hoeveni* (Rijksmuseum, Leyden,

nos. 7747 and 2626, the latter topotypic) reaches midway between the eye and the hind margin of the preopercle. In the four *hosii* at hand the barbel reaches midway between the end of the preopercle and the end of the opercle.

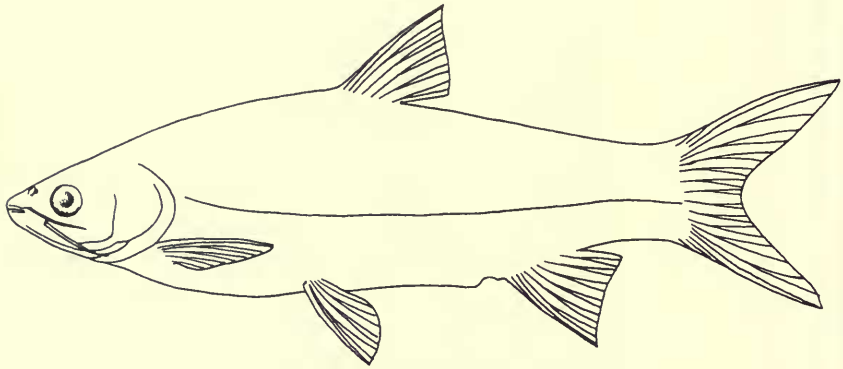

FIG. 26. *Leptobarbus hosii*.

In North Borneo this species has been collected only in turbid water of large rivers or their cut-off meanders. They are usually caught by cast nets.

Localities.—Beaufort District, Padas River at Beaufort (1); Kinabatangan District, Kinabatangan River at Lamag (1); Tenom District, Pegalan River at Tenom (2).

Leptobarbus melanotaenia Boulenger. Figure 27.

Leptobarbus melanotaenia Boulenger, 1894, Ann. Mag. Nat. Hist., (6), **13**: 246—Bongon, North Borneo; Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 97; Fowler, 1941, Bull. U. S. Nat. Mus., no. 100, **13**: 810.

Dorsal iii,7; pectoral i,13–16 (mean 14.5; N=12); ventral i,8; anal iii,5; lateral line scales 35–37 (mean 35.5; N=13); transverse scales 5½/1/4½–5½; predorsal scales 12–13 (mean 12.5; N=13); gill rakers 5–7+8–10, total 14–17 (mean total 15.8; N=13); head 0.259–0.302 (median 0.273; N=13); depth 0.257–0.324 (median 0.284; N=13); eye 0.050–0.074, decreasing as standard length increases; interorbital 0.140–0.155 (median 0.148; N=13); standard length 74.3–188 mm.; total length 99.6–247 mm.

Color in life silvery; a narrow, black, mid-lateral stripe from opercle to base of caudal; fins reddish.

One fish was collected in a cut-off meander of the Segama River, the remainder in small forest streams. Four specimens were caught in turbid water over a silt bottom, and 31 in clear water over mix-

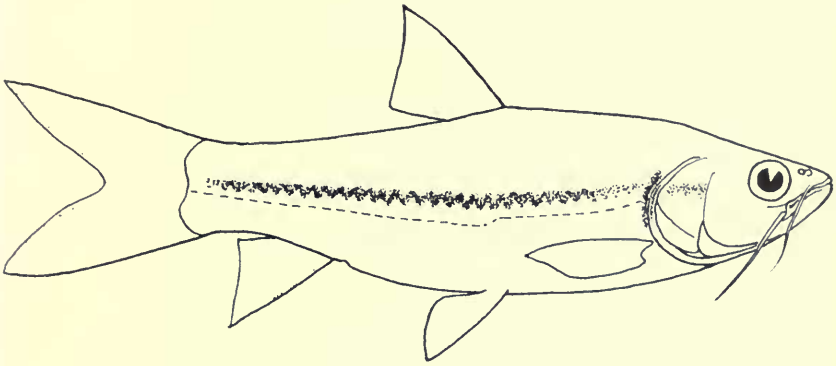

FIG. 27. *Leptobarbus melanotaenia.*

tures of silt, sand, and gravel. All food-containing stomachs (10) held vegetation—pieces of leaves, stems, and flowers.

Leptobarbus melanotaenia is similar to *hosii* in counts and body proportions, though the former's mid-lateral stripe is distinctive. The eye and interorbital widths are slightly greater in *melanotaenia* (Table 2) if comparisons are restricted to fishes of comparable size. The two forms are not geographic replacements, as both occur in the Kinabatangan basin.

TABLE 2.—Comparison of *Leptobarbus hosii* and *L. melanotaenia* from North Borneo

melanotaenia			*hosii*		
Standard length	Eye ratio	Interorbital ratio	Standard length	Eye ratio	Interorbital ratio
115	0.065	0.141			
116	0.067	0.155	125	0.054	0.140
122	0.066	0.148	129	0.058	0.142
133	0.063	0.146	136	0.053	0.130
164	0.051	0.140	150	0.048	0.130
174	0.057	0.143			

Localities.—Kinabatangan District, Deramakot (29); Kudat District, Bongon (Boulenger, 1894); Lahad Datu District, Segama River at Segama Estate (1); Tawau District, Kalabakan, Sungei Tawan (6).

Cyclocheilichthys Bleeker

The two species now known from North Borneo are easily distinguished. *Cyclocheilichthys apogon* has no barbels and 16 scales around the caudal peduncle; *C. repasson* has 4 barbels and 20 circumpeduncular scales. Both of these fishes are called "Batulang" or "Madulang" by the Orang Sungei.

Cyclocheilichthys apogon (Valenciennes). Figure 28.

Barbus apogon Valenciennes *in* Cuvier and Valenciennes, 1842, Hist. Nat. Poissons, **16:** 392—Java.

Cyclocheilichthys apogon Bleeker, 1860, Ichth. Arch. Ind. Prodr., II Cyprini, p. 378; Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3:** 156; Hardenberg, 1936, Treubia, **15:** 238.

Dorsal iv,8 (N=10); pectoral i,15–17 (mean i,15.5; N=10); ventral i,9 (N=10); anal iii,5 (N=10); lateral line scales 33–35 (mean 33.8; N=10); transverse scales 5½–6½/1/6½ (usually 5½/1/6½); predorsal scales 13–14 (only one out of ten with 13 scales); circumpeduncular scales 16 (N=10); gill rakers 3–4+7–9, total 10–12 (mean total 11.5; N=9); head 0.290–0.313 (median 0.302; N=10); depth 0.345–0.388 (median 0.364; N=10); snout 0.084–0.107 (median 0.093;

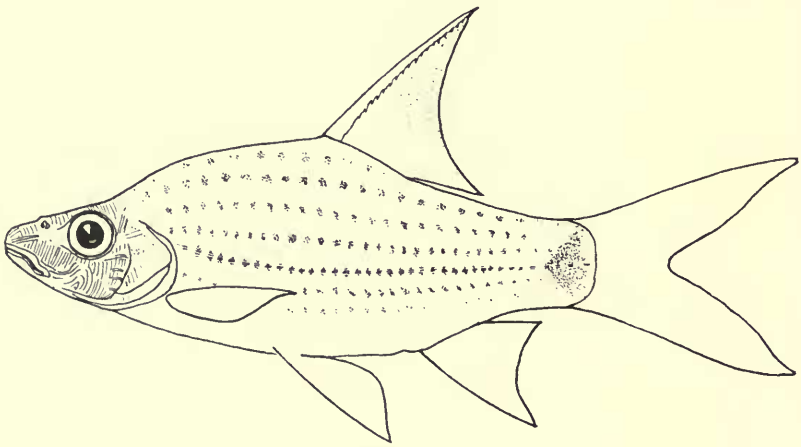

FIG. 28. *Cyclocheilichthys apogon.*

N=10); eye 0.062–0.095 (median 0.077; N=10); interorbital 0.095–0.114 (median 0.106; N=10); height-length ratio of caudal peduncle 0.954–1.051 (median 1.000; N=10); predorsal length 0.531–0.572

(median 0.546; N=10); standard length 42.0–127.2 mm.; total length 57.0–174.0 mm.

Sides with seven to eight longitudinal rows of small black spots, each on the base of a scale; a large, round, black precaudal spot three to five scales in diameter; dorsal fin dusky, the other fins colorless.

The only female from North Borneo with enlarged ova measured 127.2 mm.; one from Sarawak measured 117.2 mm. One male (114.3 mm.) had feebly developed tubercles on the predorsal scales and on the tip of the snout. A Sarawak male (110.0 mm.) had better-developed tubercles in the same position. In the latter specimen the spinous tubercles were set in small pits and barely projected above the rims of the pits. Each predorsal scale in this specimen had ten to fifteen of these nuptial tubercles.

Specimens were collected in a small forest stream (ca. 3 meters wide) having a bottom of sand and gravel. Unidentifiable insect fragments were found in four digestive tracts.

Localities.—Sandakan District, Sandakan (Weber and de Beaufort, 1916); Tawau District, Kalabakan, Sungei Tawan (10).

Cyclocheilichthys repasson (Bleeker). Figure 29.

Barbus repasson Bleeker, 1853, Nat. Tijds. Ned. Indië, **4**: 295—Pangabuang, Sumatra.

Cyclocheilichthys repasson Bleeker, 1860, Ichth. Arch. Ind. Prodr., II Cyprini, p. 370; Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 160, figs. 64–66; Hardenberg, 1936, Treubia, **15**: 238.

Dorsal iv,8 (N=28); pectoral i,16–18 (mean 16.9; N=28); ventral i,9 (N=29); anal iii,5 (N=27); lateral line scales 33–39 (mean 36.7; N=26); transverse scales 5½–6½/1/6½ (usually 6½/1/6½); predorsal scales 10–13 (mean 11.8; N=25); circumpeduncular scales 20 (N=26); gill rakers 3–5+5–7, total 8–12 (mean total 10.2; N=26); head 0.262–0.345 (median 0.293; N=27); depth 0.288–0.406 (median 0.342; N=27); snout 0.082–0.100 (median 0.089; N=19); eye 0.061–0.115 (median 0.082; N=26); interorbital 0.091–0.112 (median 0.099; N=19); height-length ratio of caudal peduncle 0.773–1.045 (median 0.885; N=17); predorsal length 0.487–0.554 (median 0.531; N=19); standard length 30.4–215.0 mm.; total length 42.6–276 mm.

Sides with eight or nine longitudinal rows of small black spots, each at the base of a scale; dorsal fin dusky; caudal fin dusky but not as dark as dorsal; other fins usually colorless though anal occasionally has a few melanophores.

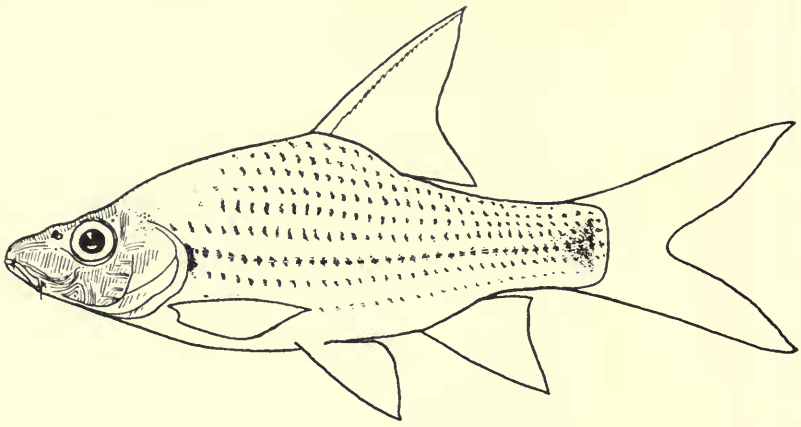

FIG. 29. *Cyclocheilichthys repasson.*

Females with enlarged ova measured 185 to 215 mm. No adult males were collected.

Specimens were collected in large, turbid rivers (33), in a cut-off meander (3), in small, turbid, silt-bottomed forest streams (113), and in small, clear, gravel-bottomed forest streams (175).

The nine digestive tracts examined contained plant fragments (2) and insect parts (8), including one mayfly nymph and several midge larvae.

Localities.—Kinabatangan District, Danau Bukit Garam (3), Lamag (2), Malapi (3), small stream one mile above Sungei Tabalin Besar (44), Deramakot (71), below mouth of Sungei Malubok (64); Lahad Datu District, Segama River at Segama Estate (2); Tawau District, Kalabakan, Sungei Tawan (92), Sungei Marikut (54), Sungei Brantian (1), Sungei Maga (1), Kalabakan River near Sungei Maga (2).

Puntius Hamilton

KEY TO SPECIES FROM NORTH BORNEO

1A. Barbels absent (fig. 30, A) ..... *bulu.*
B. Two pairs of barbels (fig. 30, B) ..... 2.
2A. Conspicuous large, round black spots on sides anterior to caudal base (fig. 30, C) ..... 3.
B. No lateral spots anterior to caudal base ..... 4.
3A. Unbranched rays of pectoral and ventral fins not longer than first branched rays (fig. 30, D) in fishes 60 mm. or larger; 12 scales around narrowest part of caudal peduncle ..... *binotatus.*

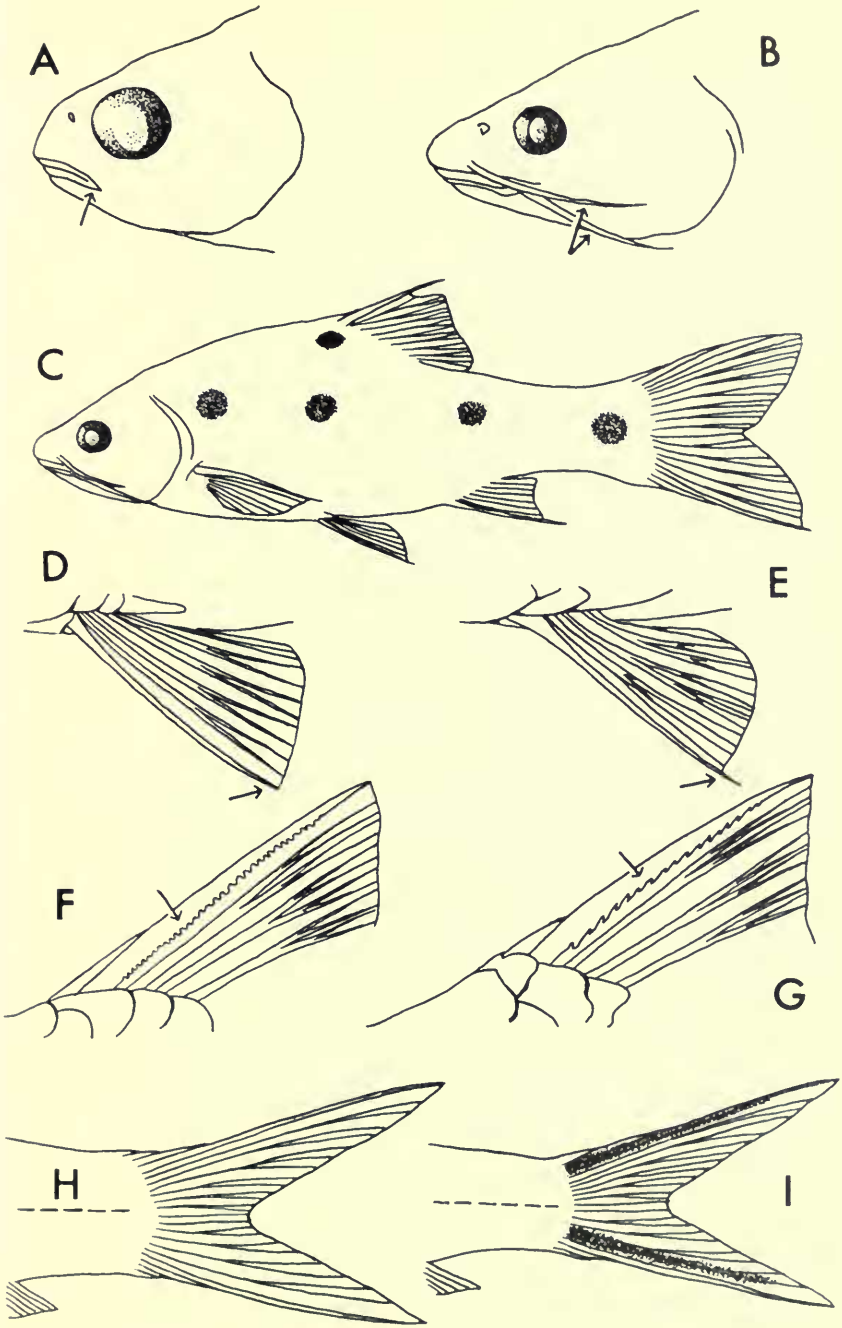

FIG. 30. Key to species of *Puntius*.

B. Unbranched rays of pectoral and ventral fins longer than first branched rays (fig. 30, E) in fishes 60 mm. or larger; 14 scales around caudal peduncle. *sealei.*

4A. Twelve scales around narrowest part of caudal peduncle..... *binotatus.*

B. Fourteen or more scales around caudal peduncle..... 5.

5A. Fourteen scales around caudal peduncle; seven black longitudinal streaks on sides..... *strigatus.*

B. Sixteen or more scales around caudal peduncle; no such streaks on sides.... 6.

6A. Dorsal spine finely serrated, with about thirty serratures (fig. 30, F). *orphoides.*

B. Dorsal spine coarsely serrated, with about eighteen serratures (fig. 30, G).. 7.

7A. Caudal faintly marked; height of caudal peduncle about equal to its length (fig. 30, H)..... *bramoides.*

B. Caudal with distinct longitudinal, marginal, black bands; height of peduncle about two-thirds of its length (fig. 30, I)..... *collingwoodi.*

In addition to the local names given to individual species, fishes of this genus are called "Duai" and "Pigos" (Orang Sungei).

Puntius bulu (Bleeker). Figure 31.

Systomus bulu Bleeker, 1851, Nat. Tijds. Ned. Indië, **2**: 207—Bandjermassin, Borneo.

Puntius bulu Bleeker, 1863, Atlas Ichth., **3**: 110, pl. 127, fig. 2; Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 199; Hardenberg, 1936, Treubia, **16**: 239.

Dorsal iv,8 (N=19); pectoral i,14–18 (mean i,16.3; N=20); ventral i,9 (N=20); anal iii,5 (N=20); lateral line scales 31–37 (mean

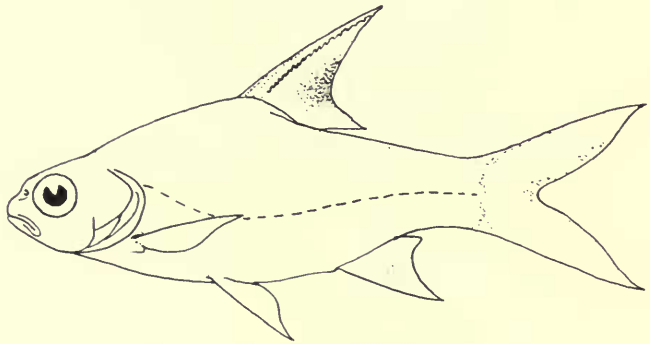

FIG. 31. *Puntius bulu.*

34.1; N=21); transverse scales 6½–7½/1/6½; predorsal scales 11–15 (mean 12.5; N=12); circumpeduncular scales 16 (N=13); gill rakers 7–14+20–26, total 27–40 (mean total 35.8; N=15); head 0.272–0.324

(median 0.299; N=21); depth 0.317–0.482; snout 0.056–0.095 (median 0.076; N=11); eye 0.066–0.106; interorbital 0.098–0.139 (median 0.114; N=19); height-length ratio of caudal peduncle 0.672–1.409 (median 1.000; N=11); standard length 24.7–228.0 mm.; total length 33.0–286 mm.

The ratios of depth and eye diameter change with standard length, depth becoming relatively greater and eye relatively smaller (Table 3).

TABLE 3.—Ontogenetic Changes in Body Proportions of *Puntius bulu* from North Borneo

Standard length	Depth of body	Eye	Standard length	Depth of body	Eye
24.7	0.323	.....	99.5	0.421	0.095
29.0	0.317	0.103	117.6	0.427	0.096
36.6	0.336	0.103	146.0	0.460	0.082
49.0	0.375	0.106	159.0	0.447	0.072
59.4	0.395	0.101	169.0	0.460	0.074
75.8	0.395	0.101	173.0	0.469	0.077
80.5	0.407	0.104	212.0	0.466	0.066
85.0	0.427	0.103	228.0	0.482	0.067
91.4	0.403	0.098			

The lateral line counts for this series are lower than those reported for *bulu*. Bleeker (1863) gave 36–37, Günther (1868) 35, and Weber and de Beaufort (1916) 37.

This species lacks conspicuous markings. Generally the coloration is silvery, darker above than below. The scales may have small vertical dark spots.

Our fishes were caught in turbid waters of the Kinabatangan River and its larger tributaries. *Puntius bulu* feeds on plant material, coming to the surface to gulp flowers and small fruits as they hit the water.

Local name.—"Moh" (Orang Sungei).

Localities.—Kinabatangan District, Lamag (1), Danau Bilit (1), Danau Bukit Garam (3), Malapi (1), Kinabatangan River at Deramakot (3), Sungei Deramakot (26); Lahad Datu District, Segama River at Segama Estate (4).

Puntius binotatus (Valenciennes). Figure 32.

Barbus binotatus Valenciennes *in* Cuvier and Valenciennes, 1842, Hist. Nat. Poissons, **16**: 168—Java.

Puntius binotatus Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 186, fig. 74; Fowler, 1941, Bull. U. S. Nat. Mus., no. 100, **13**: 790, figs. 20–23.

Puntius binotatus banksi Herre, 1940, Bull. Raffles Mus., no. 16, p. 31—Singapore, Johore, and Kuching, Sarawak.

Dorsal iv,8 (N=19); pectoral i,13–16 (mean i,14.2; N=19); ventral i,7–8 (only 2 out of 19 with 7 branched rays); anal iii,5 (N=19); lateral line scales 22–26 (mean 23.7; N=25); transverse scales

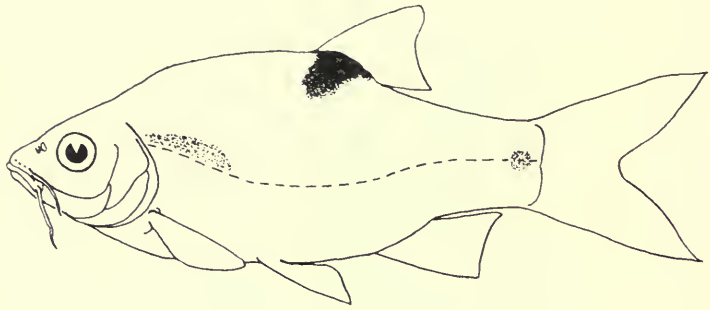

FIG. 32. *Puntius binotatus.*

4½/1/4½; predorsal scales 8–10 (mean 9.1; N=18); circumpeduncular scales 12–14 (mean 12.1; N=21); gill rakers 2–5+6–9, total 9–14 (mean total 11.4; N=19); head 0.266–0.335 (median 0.293; N=21); depth 0.304–0.386 (median 0.346; N=21); snout 0.066–0.090 (median 0.081; N=9); eye 0.067–0.096 (median 0.080; N=21); interorbital 0.100–0.124 (median 0.108; N=19); height-length ratio of caudal peduncle 0.800–0.929 (median 0.889; N=8); standard length 31.6–83.5 mm.; total length 45–110 mm.

Coloration variable; usually a series of dark, round spots, two to four in number, along mid-lateral line; all these spots may be lacking, though a predorsal spot is almost invariably present; a small, dark spot at anterior base of dorsal.

Conspicuously spotted specimens are found in North Borneo only in the West Coast area. Superficially such specimens are similar to *Puntius sealei,* which in North Borneo is found only east of the Crocker Range. But specimens 60 mm. and larger can be sorted into these two species rapidly by an examination of the pectoral and ventral fins. In *binotatus* the unbranched pectoral and ventral rays are either the same length or shorter than the first branched rays (fig. 30, D). In *sealei* these simple rays are distinctly longer than the adjacent branched rays, forming a short filament (fig. 30, E). These species also differ in scale counts. The fact that they are sympatric in the Labuk and Kinabatangan drainages proves their distinction.

The only female containing mature ova was 66.2 mm. long. Two males (73.0 and 83.5 mm.) had small, whitish tubercles scattered over the top of the head.

The five digestive tracts examined contained fragments of insects and plants.

Specimens were collected in small and medium-sized streams (one to ten meters wide) in quiet water over silt, sand, gravel, or rock bottoms. We observed no preference between clear or slightly turbid water.

Local name.—"Turungau" (Dusun).

Localities.—Jesselton District, 8 miles north of Jesselton (2), Menggatal (4); Kinabatangan District, Deramakot (20); Kota Belud District, Kota Belud (13); Labuk and Sugut District, Labuk River (1); Ranau District, Ranau (19); Tambunan District, Sungei Kaingeran (8); Tuaran District, Tuaran (5).

Herre (1933) reported *binotatus* from Sandakan. His specimens in Chicago Natural History Museum are clearly *sealei*.

Puntius sealei (Herre). Figure 30, C.

Barbus elongatus Seale, 1910, Philip. Jour. Sci., **5**, (D), p. 265, pl. 2, fig. 2—Sandakan, North Borneo (not of Rüppell).

Barbodes sealei Herre, 1933, Jour. Pan-Pacific Res. Inst., **8**, no. 4, p. 3 (new name).

Puntius sibukensis Fowler, 1941, Bull. U. S. Nat. Mus., no. 100, **13**: 799, fig. 25—Selimpopon River, North Borneo.

Puntius elongatus Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 191.

Dorsal iv,8 (N=61); pectoral i,13–16 (mean i,14.2; N=61); ventral i,7–9 (one out of 61 had 9, and seven had 7 branched rays); anal iii,5 (N=61); lateral line scales 26–32 (mean 27.4; N=72); transverse scales 4½/1/4½; predorsal scales 8–10 (mean 9.3; N=21); circumpeduncular scales 15–16 (three out of 64 had 15 scales); gill rakers 2–4+5–10, total 7–13 (mean total 10.1; N=19); head 0.261–0.306 (median 0.285; N=66); depth 0.288–0.379 (median 0.335; N=64); snout 0.062–0.086 (median 0.072; N=14); interorbital 0.103–0.123 (median 0.113; N=26); standard length 22.0–137.0 mm.; total length 29.4–172.0 mm.

The eye becomes relatively smaller as standard length increases (Table 4).

In alcohol, color of sides pale yellowish with four round or oval black spots mid-laterally; a small dark spot at anterior base of dorsal;

TABLE 4.—Ontogenetic Change in Diameter of the Eye of *Puntius sealei* from North Borneo

Standard length	Eye	Standard length	Eye	Standard length	Eye
22.0	0.100	78.5	0.061	106.5	0.055
28.4	0.102	81.3	0.067	107.0	0.058
44.2	0.083	81.9	0.067	110.0	0.055
57.1	0.077	89.3	0.055	115.0	0.053
58.3	0.078	94.5	0.061	117.5	0.049
65.5	0.065	95.5	0.059	123.8	0.048
66.5	0.064	97.0	0.061	125.0	0.051
70.0	0.068	97.5	0.057	137.0	0.047
71.7	0.066	103.0	0.058		

a similar one often present at base of anal; in life the lower pectoral rays, the entire ventral, the anterior two-thirds of the anal, and the lower caudal lobe are bright orange.

The smallest female with enlarged ova measured 79.7 mm. Adult males (over 82 mm.) had small whitish tubercles scattered over the top and sides of the head.

Puntius sealei lives in small streams (usually less than 10 meters wide) in clear or slightly turbid water, over silt, sand, or gravel bottoms.

Ten food-containing stomachs were examined (Inger, 1955, p. 62). The diet consists primarily of parts of vascular plants. The fish also eats insects and crustaceans.

Local names.—"Puteh" (Malay), "Turungau" (Dusun).

Localities.—Kinabatangan District, Sungei Gaja (38), unnamed tributaries of Sungei Kretam Kechil (86), Deramakot (141); Lahad Datu District, Sungei Edam (4); Sandakan District, Sandakan (153), Sandala Estate (16), tributary of Sungei Sapagaya (35), Tenosa near Sandakan (42), Sepilok Forest Reserve (32); Tawau District, Sebatik Island (Fowler, 1941), Selimpopon River (Fowler, op. cit.), Kalabakan, Sungei Tawan (29), Sungei Brantian (2).

Also reported from the Sibuku River in extreme northeastern Indonesian Borneo.

Weber and de Beaufort (1916) tentatively place a specimen from Kina Balu, listed by Vaillant (1893) as *maculatus* Valenciennes (=*binotatus* Valenciennes), in this species. Nothing in Vaillant's notes distinguish his specimen from either *binotatus* or *sealei*. Since *binotatus* has been collected in one of the streams draining Kina Balu, whereas *sealei* is definitely known only from farther east, Vaillant's fish probably was a *binotatus*.

Puntius strigatus (Boulenger)

Barbus strigatus Boulenger, 1894, Ann. Mag. Nat. Hist., (6), **13**: 247—Bongon, North Borneo.

Puntius strigatus Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 192.

Dorsal iii,8; anal iii,5; lateral line scales 29; transverse scales to dorsal origin 6, to ventral insertion 3; standard length 140 mm.; head 0.222; depth 0.384; eye 0.063. (Data from original description.)

Locality.—Kudat District, Bongon (Boulenger, 1894).

Puntius orphoides (Valenciennes)

Barbus orphoides Valenciennes *in* Cuvier and Valenciennes, 1842, Hist. Nat. Poissons, **16**: 193—Java.

Puntius orphoides Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 193.

Dorsal iv,8; pectoral i,14–15; ventral ii,8; anal iii,5; lateral line scales 27–29; transverse scales to dorsal origin 5–5½; predorsal scales 10–11; circumpeduncular scales 16; gill rakers 3+6; standard length 106.0–109.0 mm.; head 0.275–0.286; depth 0.335–0.341. (Data from two specimens from Thailand.)

Locality.—Sandakan (Weber and de Beaufort, 1916).

Puntius bramoides (Valenciennes). Figure 33.

Barbus bramoides Valenciennes *in* Cuvier and Valenciennes, 1842, Hist. Nat. Poissons, **16**: 160—Java.

Puntius bramoides Bleeker, 1863, Atlas Ichth., **3**: 95, pl. 126, fig. 2; Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 195.

Puntius collingwoodi (not of Günther) Fowler, 1941, Bull. U. S. Nat. Mus., no. 100, **13**: 803, fig. 26.

Dorsal iv,6–8 (one of 41 had 6 branched rays); pectoral i,13–15 (mean i,14.3; N=40); ventral ii,7–9 (of 40 specimens one had 7 and one had 9 branched rays); anal iii,5 (N=41); lateral line scales 24–32 (mean 27.8; N=47); transverse scales 5½–6½/1/4½; predorsal scales 10–12 (mean 11.0; N=41); circumpeduncular scales 16–18 (mean 16.5; N=24); gill rakers 3–6+6–11, total 9–17 (mean total 12.5; N=35); serratures on dorsal spine 15–22 (mean 18.2; N=9); head 0.220–0.304 (median 0.272; N=39); depth 0.310–0.440 (median 0.408; N=37); snout 0.046–0.082 (median 0.057; N=14); eye 0.065–0.126 (median 0.087; N=27); interorbital 0.068–0.131 (median 0.116; N=26); height-length ratio of caudal peduncle 0.828–1.087 (median 0.905; N=13); predorsal length 0.520–0.596 (median 0.554; N=13);

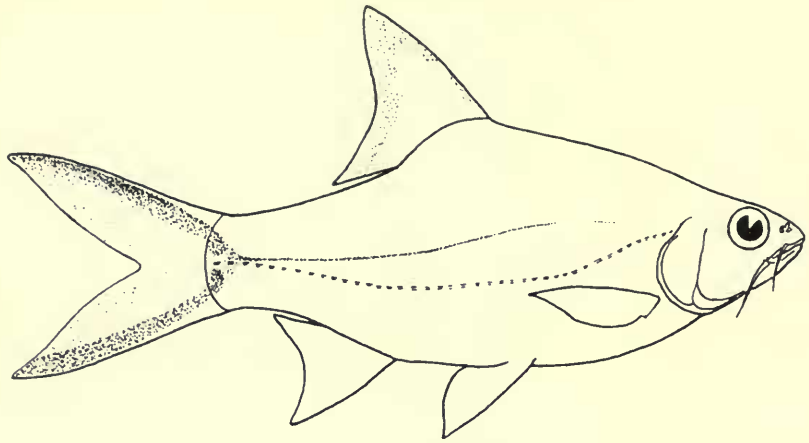

FIG. 33. *Puntius bramoides.*

height of dorsal 0.281–0.350 (median 0.310; N=10); standard length 27.4–169.0 mm.; total length 38.4–228.5 mm.

Color in life olive above, silvery below, body without markings; outer rays of caudal lobes dusky or black, inner rays often yellow or orange-red; dorsal dusky or colorless, usually the spine darker than the remainder of the fin; pectoral colorless or yellowish; ventral colorless or orange; anal sometimes dusky at the base, orange or red distally; iris yellow.

Puntius bramoides lives in streams of all sizes, from the Kinabatangan down to small tributaries less than five meters wide. It shows no preference between clear or turbid water and lives over silt, sand, or gravel bottoms.

The five digestive tracts examined contained plant and insect fragments. Among the last were larvae of Simuliidae.

The specimens listed by Fowler (1941) as *collingwoodi* have been examined and are identical with other *bramoides.*

Local names.—"Puteh" (Malay), "Selap" (Dusun of Keningau), "Lontong" (Orang Sungei).

Localities.—Kinabatangan District, Danau Bilit (1), Danau Bukit Garam (3), Danau Duadan (1), Lamag (3), Malapi (1), Abai (1), Deramakot (29); Labuk and Sugut District, Labuk River (1); Lahad Datu District, Segama River at Segama Estate (10); Tawau District, Kalabakan, Sungei Tawan (60), Kalabakan River (41), Sungei Marikut (8), Sungei Maga (9), Sungei Brantian (1), Selimpopon River (14), Sungei Tawau (19).

Puntius collingwoodi (Günther). Figure 34.

Barbus collingwoodi Günther, 1868, Cat. Fishes Brit. Mus., 7: 483—Sarawak.

Puntius collingwoodi Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., 3: 196.

Dorsal iv,8 (N=13); pectoral i,13–14 (mean i,13.8; N=13); ventral i,8 (N=13); anal iii,5 (N=13); lateral line scales 30–34 (mean 32.2; N=15); transverse scales 5½–6½/1/4½; predorsal scales 12–14 (mean 12.3; N=15); circumpeduncular scales 16 (N=15); gill rakers 2–4+6–9, total 8–12 (mean total 9.9; N=14); serratures on dorsal spine 15–22 (mean 17.9; N=10); head 0.237–0.280 (median 0.255; N=15); depth 0.243–0.362 (median 0.316; N=15); snout 0.054–0.077 (median 0.069; N=13); eye 0.069–0.106 (median 0.093; N=13); interorbital 0.083–0.095 (median 0.088; N=13); height-length ratio of caudal peduncle 0.507–0.704 (median 0.664; N=13); standard length 30.0–121.5 mm.; total length 40.5–168.0 mm. (Data from 2 specimens from North Borneo and 13 from Sarawak.)

Color in life olive above, silvery below, scales of upper half of body usually with dark vertical bars; outer rays of upper caudal lobe dusky to black, those of lower lobe black, inner rays yellowish; dorsal spine and first two branched rays black, the next three rays orange-red at tips, remainder of dorsal colorless; pectoral and ventral colorless at base, the outer rays often tinged with yellow or pink.

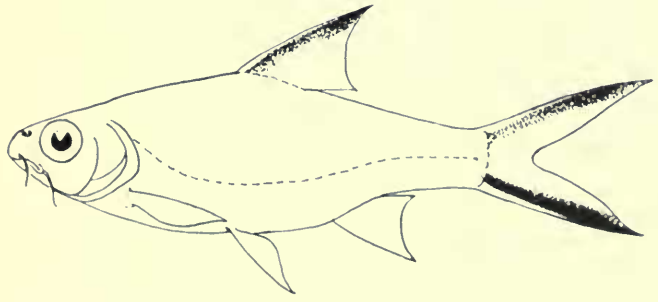

FIG. 34. *Puntius collingwoodi.*

A female with mature ova measured 121.5 mm.

The two North Bornean specimens were collected in clear water over a gravel and rock bottom.

Locality.—Kota Belud, Tempasuk River (2).

Hampala macrolepidota van Hasselt

Hampala macrolepidota van Hasselt, 1823, Alg. Konst. Letterbode, **2**: 132—Java; Fowler, 1905, Proc. Acad. Nat. Sci. Philadelphia, **57**: 486; Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 143, fig. 60; Rendahl, 1922, Medd. Zool. Mus. Kristiana, **60**: 203; Hardenberg, 1936, Treubia, **15**: 238; Inger, 1955, Fieldiana, Zool., **37**: 62.

Barbus hampal bimaculata Popta, 1904, Notes Leyden Mus., **25**: 173—Howong, Bo, Kajan Rivers, Borneo.

Barbus hampal bifasciata Popta, loc. cit.—Bo River, Borneo.

Dorsal iv,8 (N=43); pectoral i,13–15 (mean i,13.9; N=43); ventral i,7–9 (of 43 specimens three had 7 and one had 9 branched rays); anal iii,5 (N=43); lateral line scales 25–31 (mean 27.5; N=47); transverse scales 4½–5/1/4½ (usually 4½/1/4½); predorsal scales 8–10 (mean 9.9; N=15); circumpeduncular scales 12–16 (mean 13.8; N=47); gill rakers 2–3+6–10, total 8–12 (mean total 10.4; N=23); serrations on dorsal spine 15–25 (mean 21.4; N=17); head 0.286–0.375 (median 0.340; N=44); depth 0.244–0.330 (median 0.279; N=44); snout 0.078–0.118 (median 0.098; N=17); eye 0.048–0.105 (median 0.069; N=19); interorbital 0.089–0.107 (median 0.097; N=14); height-length ratio of caudal peduncle 0.592–0.909 (median 0.733; N=17); standard length 13.6–385 mm.; total length to 490 mm.

Brownish above, lighter below; a vertical black band on side below dorsal; a second vertical band or spot on caudal peduncle present or absent; upper and lower edges of caudal black; anterior rays of dorsal usually dusky, remainder of fins colorless. The black markings on the sides usually disappear when the fish is about 300 mm. long.

Enlarged ova were found in a female 153 mm. long. Males larger than 100 mm. had small, whitish tubercles scattered over the head and body.

Hampala is much more abundant in clear water than in turbid; only 10 of 139 specimens were collected in turbid water. The clear water habitats had sand, gravel, or rock bottoms, whereas the turbid water occurred over silt bottoms.

Four small specimens (31.8–60.5 mm.) contained insect fragments and eggs of an unknown invertebrate. Larger specimens (over 100 mm.) feed largely on fishes (Inger, 1955). Probably the habit of feeding on fishes accounts for the preference for clear water habitats. *Hampala* probably hunts by sight, judged by its large eyes.

This species shows much geographic variation in coloration and counts. A single dark blotch is present below the dorsal fin of fishes from Sumatra and Java (the type locality). Fishes from central and

TABLE 5.—Frequency Distribution of *Hampala macrolepidota* with Respect to Certain Characters

	Lateral Line Scales						
	25	*26*	*27*	*28*	*29*	*30*	*31*
Sandakan–Kinabatangan		3	3	13	10	1	1
Lahad Datu–Tawau	5	1	5				
West coast		2	1				
Sarawak		10	3	1			
bimaculata[1]	+	+	+				
macrolepidota[1]				+	+		

	Circumpeduncular Scales					Branched Pectoral Rays			
	12	*13*	*14*	*15*	*16*	*13*	*14*	*15*	*16*
Sandakan–Kinabatangan	1	1	13	18	4	10	20		
Lahad Datu–Tawau	11						6	4	
West coast	3							3	
Sarawak	13						2	6	4
bimaculata[1]	+						+	+	+
macrolepidota[1]	+							+	+

	Gill Rakers (total)					
	8	*9*	*10*	*11*	*12*	*13*
Sandakan–Kinabatangan	2	5	5	5		
Lahad Datu–Tawau			1	3	4	
West coast				2	1	
Sarawak			1	5	4	3

Serrations on Dorsal Spine (specimens over 100 mm.)					
	7–10	*11–14*	*15–18*	*19–22*	*23–26*
Sandakan–Kinabatangan			2	2	5
Lahad Datu–Tawau			1	2	3
West coast			2		
Sarawak	1	6	2		

[1] Data on ranges of variation taken from Weber and de Beaufort (1916).

northern Sarawak and central Indonesian Borneo have two blotches, one below the dorsal fin and one on the caudal peduncle. Specimens from the Tawau and Lahad Datu areas of southeastern North Borneo have two blotches—one on the caudal peduncle—when they are in the size range below 45 mm. (fig. 37); above that size the marking on the caudal peduncle is lost. Fishes from the west coast of North Borneo have a faint spot on the caudal peduncle as well as the usual marking below the dorsal. Only the blotch below the dorsal is present in fishes from the Kinabatangan basin (fig. 36). Differences in counts can be seen in Table 5.

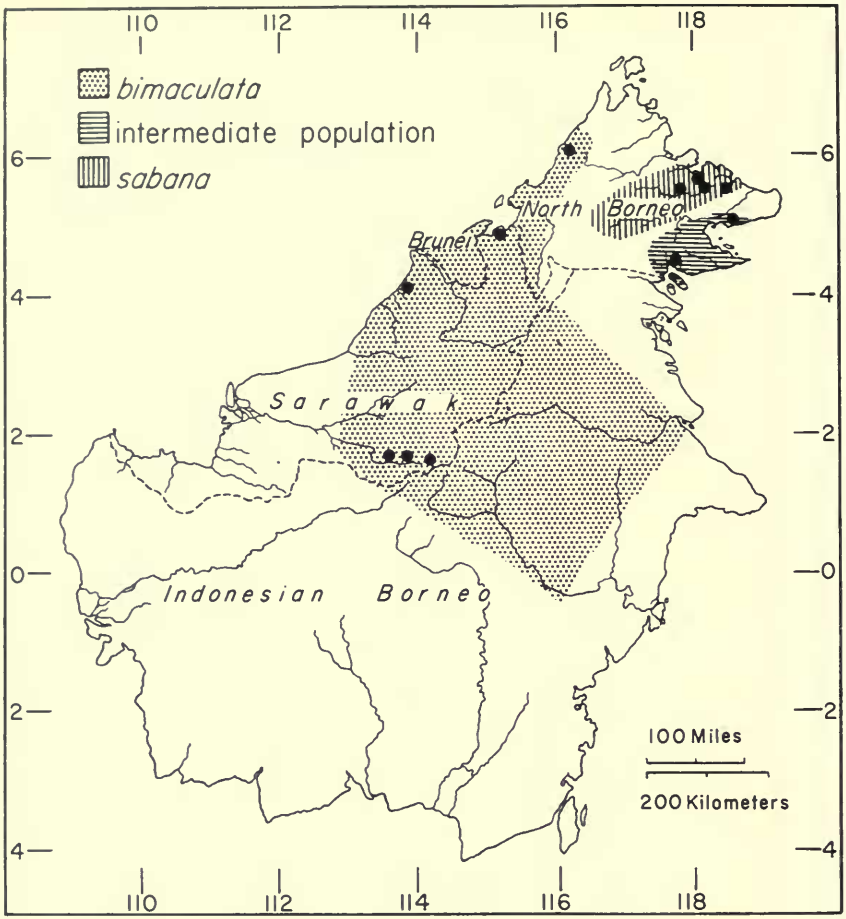

FIG. 35. Distribution of forms of *Hampala macrolepidota* in Borneo.

Specimens from Sarawak and the west coast of North Borneo agree with *bimaculata* and differ from *macrolepidota* in coloration and lateral line counts. The Kinabatangan and Sandakan specimens differ from *bimaculata* in coloration and counts, and from *macrolepidota* in the number of pectoral rays and circumpeduncular scales. The fishes from the Tawau and Lahad Datu areas are intermediate between *bimaculata* and the Kinabatangan form.

The geographic variation observed warrants the recognition of at least two subspecies in Borneo (fig. 35): (1) *bimaculata* in central Indonesian Borneo, central and northern Sarawak, and the west coast

of North Borneo; (2) a new subspecies, described below as *macrolepidota sabana*, from the Kinabatangan basin and the streams draining into Sandakan Harbor. We have seen no specimens from western Borneo but we judge from Weber and de Beaufort (1916) that specimens from that area differ from *bimaculata* in counts and color.

Local names.—"Barap" or "Gorap" (Dusun, Orang Sungei and Murut).

Hampala macrolepidota sabana, new subspecies. Figure 36.

Holotype.—Chicago Natural History Museum no. 68218, from a small tributary of the Kinabatangan River near Deramakot. Collected May 2, 1956, by P. K. Chin and R. F. Inger.

Paratypes.—CNHM 68219 (7) from the type locality; CNHM 68220 (1), 68221 (1), 68222 (1), 68223 (4) and 68224 (1) from Deramakot; CNHM 51579 (4), 51583 (1), 51578 (21) and 51582 (71) from Sungei Gaja; CNHM 51581 (1) from Sungei Pinang; CNHM 51577 (2) and 51580 (6) from a tributary of Sungei Sapagaya; CNHM 44729 (12) from Kinabatangan area (exact locality unknown); CNHM 44730 (1) from Lamag.

Diagnosis.—A form of *Hampala macrolepidota* distinguished by having 12–16 (usually 14–16) scales around the caudal peduncle and 13–14 branched pectoral rays.

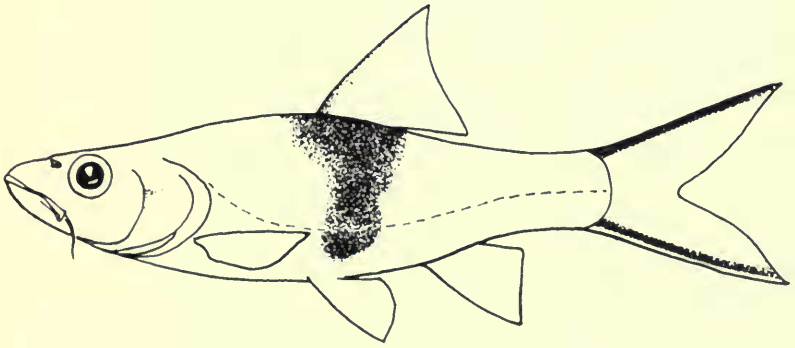

FIG. 36. *Hampala macrolepidota sabana.*

Description (data on holotype in parentheses).—Dorsal iv,8 (iv,8) (N=31); pectoral i,13–14 (i,14) (mean i,13.6; N=31); ventral i,7–9 (i,8) (only two had 7 and one had 9 branched rays); anal iii,5 (iii,5) (N=31); lateral line scales 26–31 (29) (mean 28.1; N=33); transverse

scales 4½–5/1/4½ (4½/1/4½); predorsal scales 8–10 (10) (mean 9.6; N=10); circumpeduncular scales 12–16 (14) (mean 14.6; N=33); gill rakers 2–3+6–9 (2+8), total 8–11 (mean total 9.7; N=18); serrations on dorsal spine 18–25 (24) (mean 22.0; N=9); head 0.313–0.375 (0.341) (median 0.338; N=32); depth 0.248–0.330 (0.276) (median 0.279; N=32); snout 0.092–0.113 (0.105) (median 0.099; N=11); eye 0.048–0.083 (0.068) (median 0.068; N=8); interorbital 0.091–0.104 (0.095) (median 0.095; N=8); height-length ratio of caudal peduncle 0.592–0.790 (0.683) (median 0.680; N=10); standard length 51.0–230 mm.; total length 76.0–283 mm.

Remarks.—Comparison with other populations is made in Table 5 and in the preceding discussion.

Localities.—Kinabatangan District, Deramakot (16), Sungei Gaja (106), Lamag (1), Sungei Pinang (1), unknown locality (12); Sandakan District, tributary of Sungei Sapagaya (8).

Hampala macrolepidota sabana × bimaculata. Figure 37.

The characters of this intermediate population are given in the preceding discussion and in Table 5.

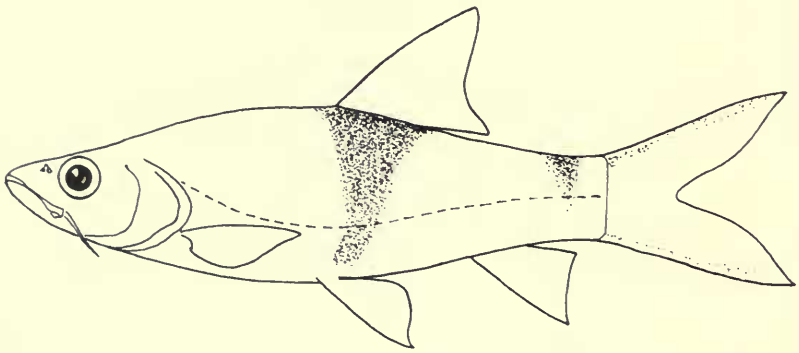

FIG. 37. *Hampala macrolepidota sabana × bimaculata.*

Localities.—Lahad Datu District, Sungei Edam (5); Tawau District, Sungei Tawan (9), Sungei Marikut (7), Kalabakan River near Sungei Maga (1).

Hampala macrolepidota bimaculata Popta

The characters of this subspecies are given in the preceding discussion and in Table 5.

Locality.—Kota Belud District, Tempasuk River (3).

Tor douronensis (Valenciennes). Figure 38.

Barbus douronensis Valenciennes *in* Cuvier and Valenciennes, 1842, Hist. Nat. Poissons, **16**: 187—Java.

Tor douronensis Smith, 1945, Bull. U. S. Nat. Mus., no. 188, p. 139.

Labeobarbus douronensis Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 150.

Dorsal iv,9 (N=7); pectoral i,14–15 (mean i,14.3; N=7); ventral i,8 (N=7); anal iii,5 (N=7); lateral line scales 19–22 (mean 21.3; N=7); transverse scales 3½/1/3½; predorsal scales 8–9 (mean 8.6; N=6); circumpeduncular scales 12 (N=7); gill rakers 2–5+12–15, total 15–20 (mean total 16.1; N=6); head 0.263–0.291 (median 0.282; N=7); depth 0.300–0.321 (median 0.312; N=6); snout 0.076–0.086 (median 0.081; N=6); eye 0.065–0.105 (median 0.087; N=7); interorbital 0.084–0.109 (median 0.096; N=6); height-length ratio of caudal peduncle 0.598–0.752 (median 0.722; N=6); standard length 52.2–66.0 mm.; total length 70.0–84.0 mm.

Color in alcohol grayish brown, lighter below; scales on sides with dark vertical bars; dorsal and caudal fins dusky; other fins colorless or slightly dusky.

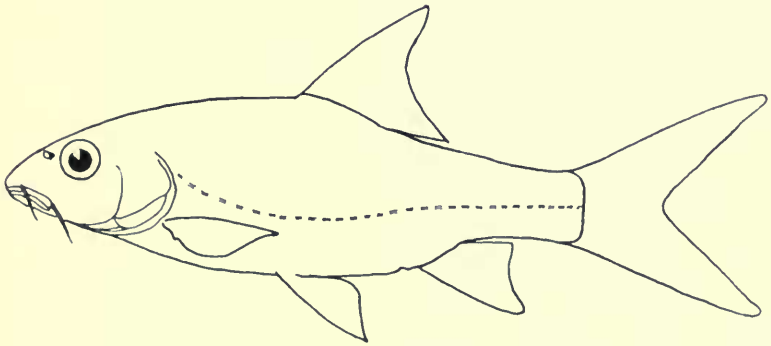

FIG. 38. *Tor douronensis.*

To the best of our knowledge this species lives only in swift, clear, rocky-bottomed streams in North Borneo. Small individuals may be found in shallow water, but adults live in the deeper pools (up to 5 meters deep). This fish, which commonly reaches 40 cm., is highly esteemed for food by the people of western North Borneo. It is usually caught with a cast net.

Local name.—"Belian" (Dusun).

Localities.—Keningau District, Sungei Membikit (4); Kota Belud District, Tempasuk River (2), Tempasuk River 3 miles above Kaung (1); Tambunan District, Sungei Kaingeran (4).

Lobocheilus bo (Popta). Figure 39.

Tylognathus bo Popta, 1904, Notes Leyden Mus., **24**: 199—Bo River, Borneo; Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 221.

Lobocheilus bo Smith, 1945, Bull. U. S. Nat. Mus., no. 188, p. 239.

Dorsal iii,8 (N=14); pectoral i,14–17 (mean i,15.0; N=14); ventral i,8–9 (only 1 out of 14 had 9 branched rays); anal iii,5 (N=14); lateral line scales 30–34 (mean 31.5; N=14); transverse scales 5½/1/5½; predorsal scales 11–12 (mean 11.4; N=13); circumpeduncular scales 16 (N=14); gill rakers 5–11+25–33, total 30–43; head 0.225–0.296; depth 0.247–0.316 (median 0.281; N=14); snout 0.075–0.100 (median 0.088; N=9); interorbital 0.113–0.124 (median 0.118; N=9); height-length ratio of caudal peduncle 0.657–0.814 (median 0.711; N=9); standard length 43.8–205.5 mm.; total length 60.5–283.0 mm.

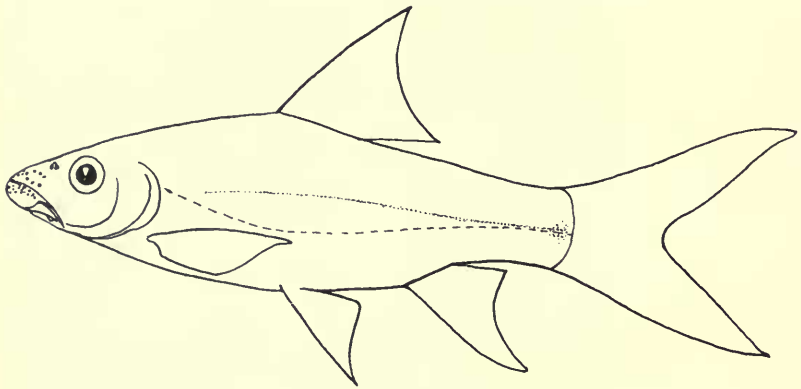

FIG. 39. *Lobocheilus bo.*

Certain body proportions and the gill raker counts change as the fish grows (Table 6).

Color in alcohol brownish above, lighter below; each scale above the lateral line with a dark tip; a dark precaudal spot covering one or two scales present or absent; fins colorless.

Not even our largest specimen (205 mm.) showed signs of sexual maturity. Every fish larger than 40 mm. had tubercles on the snout.

TABLE 6.—Relations of Body Proportions and Gill Raker Counts to Standard Length of *Lobocheilus bo* from North Borneo

Standard length	43.8	53.6	62.0	69.3	73.5	76.2	80.0
Head	0.296	0.274	0.274	0.274	0.278	0.259	0.259
Depth of body	0.289	0.270	0.258	0.285	0.278	0.286	0.316
Eye		0.085	0.079	0.079	0.077	0.072	0.062
Gill rakers		5+25	7+26	7+25	8+27	7+27	8+25

Standard length	88.6	91.5	96.4	149.0	173.0	187.0	205.5
Head	0.248	0.244	0.245	0.229	0.226	0.225	0.236
Depth of body	0.287	0.303	0.291	0.247	0.253	0.255	0.276
Eye	0.062	0.065	0.059	0.048	0.041	0.041	0.047
Gill rakers	7+30	8+27	9+27	10+31	11+32	8+32	8+33

TABLE 7.—Frequency Distribution of *Lobocheilus bo* with Respect to Certain Characters

	Branched Pectoral Rays					
	12	*13*	*14*	*15*	*16*	*17*
North Borneo			3	8	2	1
Sarawak	1	4	5			

	Lateral Line Scales					
	30	*31*	*32*	*33*	*34*	*35*
North Borneo	2	5	6		1	
Sarawak					5	5

	Predorsal Scales			Precaudal Spot
	10	*11*	*12*	
North Borneo		7	6	indistinct
Sarawak	2	3	5	distinct

Minor differences between fishes from North Borneo and Sarawak in counts and coloration are shown in Table 7.

This species lives in small streams as well as large rivers, in clear (32) as well as turbid (259) water, over gravel as well as silt bottoms.

The gut is long and convoluted and contained finely divided material. Smears from three stomachs contained diatoms, filamentous algae, small fragments of larger plants, and small sand grains.

This fish is highly esteemed as a food fish by the people of North Borneo. It is usually caught by cast net.

Local names.—"Kalauis" and "Serauyi" (Dusun); "Belanak Sungei" (Orang Sungei).

Localities.—Kinabatangan District, small stream one mile above Sungei Tabalin Besar (28), Deramakot (28), Kinabatangan River below mouth of Sungei Malubok (229); Kota Belud District, Tempasuk River (4); Lahad Datu District, Segama River at Segama Estate (2).

Schismatorhynchus heterorhynchus (Bleeker). Figure 40.

Lobocheilus heterorhynchus Bleeker, 1853, Nat. Tijds. Ned. Indië, **5**: 524—Solok, Sumatra.

Schismatorhynchus heterorhynchus Bleeker, 1860, Ichth. Arch. Ind. Prodr., II Cyprini, p. 131; Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 216–218, figs. 84–86.

Dorsal iv,8 (N=9); pectoral i,14–15 (mean i,14.7; N=9); ventral i,8 (N=9); anal iii,5 (N=9); lateral line scales 29–31 (mean 30.1;

N=10); transverse scales 5½/1/4½–5½ (usually 5½/1/5½); predorsal scales 10–12 (mean 11.0; N=10); circumpeduncular scales 16 (N=10); gill rakers 5–7+22–25, total 28–32 (mean total 30.0; N=7); head 0.241–0.295 (median 0.255; N=10); depth 0.260–0.284 (median

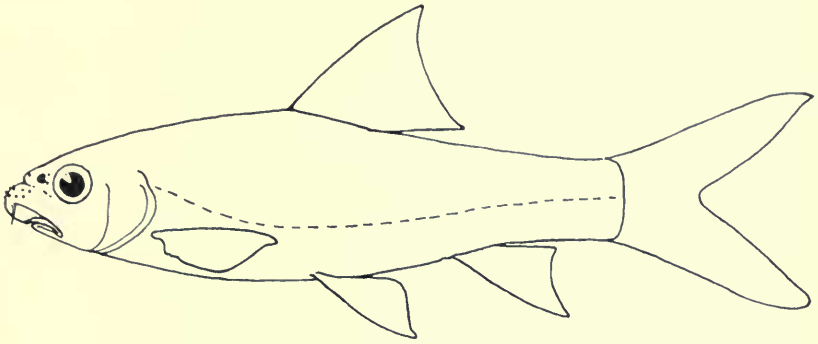

FIG. 40. *Schismatorhynchus heterorhynchus.*

0.268; N=10); snout 0.078–0.099 (median 0.090; N=8); eye 0.060–0.086 (median 0.070; N=9); interorbital 0.096–0.109 (median 0.102; N=9); height-length ratio of caudal peduncle 0.744–0.846 (median 0.789; N=9); standard length 29.8–78.7 mm.; total length 40.0–110.0 mm.

Color in alcohol yellowish brown above, lighter below; an indistinct dark mid-lateral streak; a small black precaudal spot; fins colorless.

At all sizes larger than 29 mm. the snout bears large spinous tubercles. When the fish is about 45 mm., the larger of these tubercles become branched at their tips, a development leading to star-shaped tubercles in specimens larger than 70 mm. None of our specimens has the fantastically split snout figured by Weber and de Beaufort (1916, figs. 84–85). Instead, ours, which are immature (largest 88.7 mm.), have a soft area in the approximate position of the notch in the snout of the adult (283 mm.) figured by Weber and de Beaufort.

Specimens were collected in small streams (less than 10 meters wide) as well as rivers, in clear as well as turbid water, and over silt, sand, and gravel bottoms. The largest sample was collected on a gravel bar in the Kinabatangan River.

This species feeds on bottom detritus and has a long, convoluted digestive tract. Smears made from three stomachs contained dia-

toms, blue-green algae, filamentous algae, small fragments of larger plants, and fine sand grains.

Local names.—"Lagai" (Orang Sungei) and "Salab" (Dusun).

Localities.—Kinabatangan District, small stream one mile above Sungei Tabalin Besar (28), Deramakot (8), Kinabatangan River below mouth of Sungei Malubok (158).

Tylognathus caudimaculatus Fowler

Tylognathus caudimaculatus Fowler, 1934, Proc. Acad. Nat. Sci. Philadelphia, 86: 133, figs. 89–90—Chieng Mai, Thailand.

Dorsal iii,8 (N=11); pectoral i,13–15 (mean i,14.2; N=11); ventral i,7–8 (mean i,7.8; N=11); anal iii,5 (N=11); lateral line scales 30–33 (mean 31.3; N=7); transverse scales 5–5½/1/4½–5; gill rakers 6+23–28 (N=2); head 0.253–0.319; depth 0.273–0.294; standard length 33.5–75.1 mm.; total length 44.0–103.0 mm.

These specimens are so faded that a color description cannot be given.

This identification is uncertain. The median superficial division of the lower lip does not overlap the lateral portions. A thick fleshy pad is not present in the floor of the mouth. These two negative characters seem to limit the possible affinities to the genus *Tylognathus* Heckel as restricted by Smith (1945).

These fishes differ from Fowler's description (1934) of *caudimaculatus* in having only three scales between the lateral line and the ventral fin instead of four. Smith (1945) identified as *caudimaculatus* a Thailand fish having three scales separating the ventral fin from the lateral line, but that specimen had 37 lateral line scales. The type series had 29–31 according to Fowler.

In gill raker count, in length, and in coloration the Bornean sample agrees with Fowler's description.

Localities.—Kinabatangan District, Kinabatangan River (24), Danau Duadan (38), Lamag (1).

Tylognathus sp.

Dorsal ii–iii,8; pectoral i,13–14; ventral i,8; anal iii,5; lateral line scales 30–32; transverse scales between lateral line and dorsal origin 5, to ventral insertion 2½–3; head 0.288–0.319; standard length 13.5–22.0 mm.

Color in alcohol pale brown, darker dorsally; a thin, black, midlateral line ending in a round, black precaudal spot.

The median superficial portion of the lower lip does not overlap the lateral portions. If the lateral expansion of the median lobe is not determined by age, these juveniles fit Smith's restricted definition of *Tylognathus* Heckel. However, the possession of two pairs of barbels distinguishes them from all of the southeastern Asiatic forms.

If the median portion of the lower lip expands to cover the entire lip as the fish increases in size, these may be young *Lobocheilus* van Hasselt. In that case, they might be the young of *L. lehat* Bleeker (type locality, Java), *falcifer* Valenciennes (type locality, Java), or *schwanefeldi* Bleeker (type locality, Sumatra) although they differ slightly from descriptions of those species.

Locality.—Kinabatangan District, Danau Bukit Garam (10).

Osteochilus Günther

KEY TO SPECIES FROM NORTH BORNEO

1A. Four or $4\frac{1}{2}$ scale rows between lateral line row and origin of dorsal; 10 or 11 branched dorsal rays (rarely 12) ..... *spilurus.*

B. Five or $5\frac{1}{2}$ scale rows between lateral line row and origin of dorsal; usually 12 or more branched dorsal rays ..... 2.

2A. Two or more large tubercles or pores[1] on snout (fig. 41) ..... *microcephalus.*

B. No tubercles or pores on snout ..... *vittatus.*

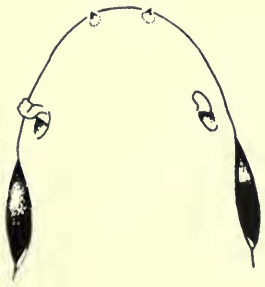

FIG. 41. Tubercles on snout of *Osteochilus microcephalus.*

The people of North Borneo apply several names to this genus without distinguishing among the species. These names are: "Alangoi," "Toros," "Logau," and "Orongol" (Dusun and Orang Sungei); "Puteh" (Malay).

[1] Sometimes conical tubercles are absent and large pores are found in their stead.

All species of this genus are detritus feeders and the extremely long, convoluted digestive tracts contained cryptogamic plants, vascular plant fragments, minor amounts of finely reduced animal material, and sand grains.

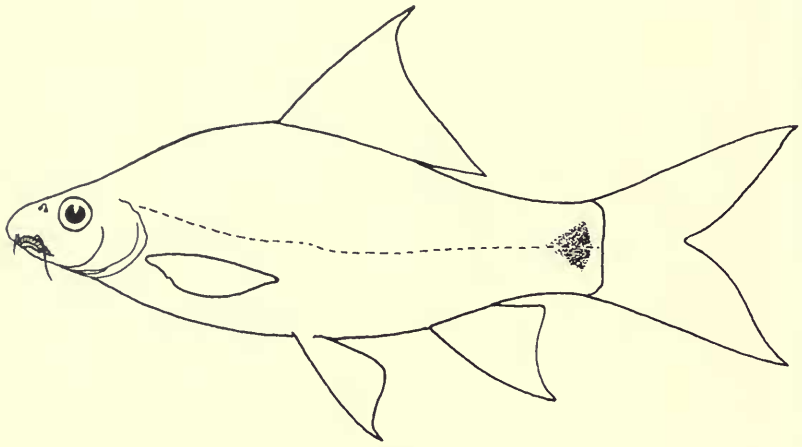

FIG. 42. *Osteochilus spilurus*.

Osteochilus spilurus (Bleeker). Figure 42.

Dangila spilurus Bleeker, 1850, Nat. Tijds. Ned. Indië, **1**: 272—Bandjermassin, Borneo.

Osteochilus spilurus Günther, 1868, Cat. Fishes Brit. Mus., **7**: 45; Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 139.

Dorsal iv,10–12 (mean iv,10.8; N=34); pectoral i,12–15 (mean i,13.5; N=34); ventral i,7–8 (only 3 out of 34 had 7 branched rays); anal iii,5 (N=34); lateral line scales 29–32 (mean 30.2; N=33); transverse scales 4½–5/1/5½–6½ (usually 4½/1/5½); predorsal scales 9–11 (mean 9.7; N=16); circumpeduncular scales 16 (N=14); gill rakers 8–13+24–32, total 32–45 (mean total 38.4; N=14); head 0.220–0.264 (median 0.239; N=34); depth 0.298–0.350 (median 0.323; N=32); snout 0.074–0.097 (median 0.081; N=11); eye 0.046–0.066 (median 0.057; N=13); interorbital 0.111–0.129 (median 0.123; N=13); height-length ratio of caudal peduncle 0.822–1.000 (median 0.942; N=10); standard length 57.4–114.3 mm.; total length 79.4–156.3 mm.

Color in alcohol olive brown above, lighter below; most of dorsal scales with a short vertical dark bar, bars not forming stripes; a large

round black spot at base of caudal; membrane of dorsal fin dusky; other fins colorless. In life anterior scales with red spots.

Larger specimens with minute whitish tubercles on top of head and snout; no large tubercles or pores at end of snout.

Two females with enlarged ova measured 107.0 and 114.3 mm.

All of our specimens were collected in small clear streams having sand and gravel bottoms which are covered with dead leaves in the quiet pools.

The convoluted gut is about 10–11 times the body length, being 1,130 and 1,200 mm. long in two fishes having standard lengths of 104 and 110 mm., respectively. Smears made from 11 digestive tracts revealed diatoms in 10, fungal hyphae and spores in 8, vascular plant fragments in 5, filamentous algae in 1, and arthropod fragments in 5.

Localities.—Kinabatangan District, Sungei Gaja (97); Lahad Datu District, Sungei Edam (4); Tawau District, Kalabakan, Sungei Tawan (49).

Bandjermassin, in southeastern Borneo, is the only other definite locality on the island. Weber and de Beaufort (1916) listed "British North Borneo."

Osteochilus microcephalus (Valenciennes). Figure 43.

Rohita microcephalus Valenciennes *in* Cuvier and Valenciennes, 1842, Hist. Nat. Poissons, **16**: 275—Java.

Osteochilus vittatus (part) Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 131.

Weber and de Beaufort based their description of *vittatus* on that of Bleeker (1863, p. 68). As pointed out by Guibé and Spillmann (1957), Bleeker's *vittatus* is not the same species as *vittatus* Valenciennes. According to Dr. Boeseman (in litt.) of the Rijksmuseum van Natuurlijke Historie, the types of *microcephalus* are conspecific with *vittatus* Bleeker. Valenciennes' species has pores (or tubercles) on the rostrum and, consequently, does not belong in the synonymy of *hasselti* Weber and de Beaufort (not of Valenciennes). Dr. Boeseman writes that the types of *microcephalus* are dried, stuffed, and varnished so that the coloration is obscured, but that an indication of a mid-lateral dark band is still present.

Probably several valid species have been lumped by Weber and de Beaufort under the heading of *vittatus* Bleeker (= *microcephalus* Valenciennes). One of them, *enneaporos* Bleeker (type locality, Sumatra), is distinguished by having a large, conical, rostral tubercle

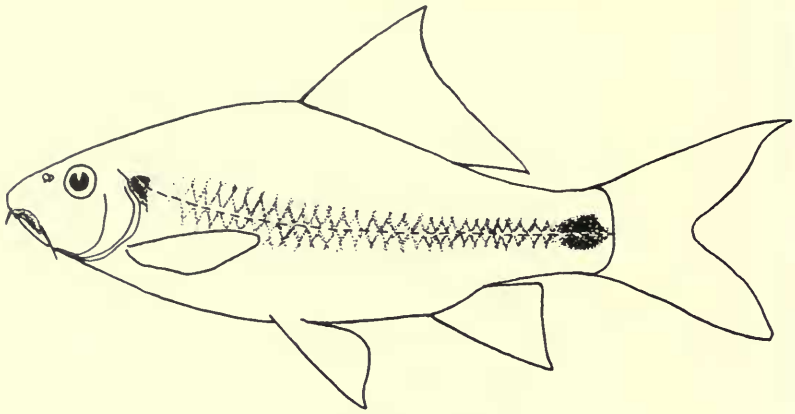

FIG. 43. *Osteochilus microcephalus.*

surrounded by a ring of smaller ones. We have six Sarawak specimens resembling Bleeker's descriptions (1852, 1863) and figures (1863) of *enneaporos.* They have the ring-like cluster of rostral tubercles and pores and a smooth-edged black lateral stripe ending in a wider precaudal spot. Specimens from Malaya and Thailand have a smooth-edged lateral stripe reaching the ends of the middle caudal rays, but no ring of pores on the snout.

Fishes in a large North Bornean sample had two or three large pores or tubercles on the snout (fig. 41), thus resembling *microcephalus,* and a serrated, black, mid-lateral stripe ending in a precaudal spot. These fishes have lower lateral line (30–33) and higher dorsal ray counts (11–14, mostly 13) than those given by Weber and de Beaufort for *vittatus* Bleeker (lateral line 33–34, dorsal rays 10–13). The North Bornean sample probably represents a new form, but so much confusion now surrounds this group that we are describing it below without applying a new name.

Dorsal iv,11–14 (mean iv,12.9; N=23); pectoral i,13–16 (mean 14.9; N=21); ventral i,8–9 (only 2 out of 22 had 9 branched rays); anal iii,5 (N=22); lateral line scales 30–33 (mean 31.5; N=22); transverse scales 5½/1/6½–7½ (usually 5½/1/6½); predorsal scales 10–12 (mean 10.4; N=22); circumpeduncular scales 16–17 (only 1 out of 22 had 17 scales); gill rakers 7–11+19–29, total 27–39 (mean total 34.4; N=17); head 0.225–0.302 (median 0.255; N=21); depth 0.315–0.383 (median 0.347; N=18); snout 0.072–0.094 (median 0.081; N=13); eye 0.048–0.075 (median 0.063; N=19); interorbital 0.119–0.146 (median 0.130; N=19); height-length of caudal peduncle 0.875–

1.163 (median 1.000; N=13); standard length 37.2–142.5 mm.; total length 52.0–192.0 mm.

Usually a pair of large, whitish tubercles at tip of snout, a few specimens with a third median tubercle; most specimens with a series of smaller tubercles above and to the sides of the larger ones.

Margin of dorsal fin concave, the last simple ray and the first branched one the longest; pectoral fin bluntly pointed, well separated from ventral; ventral fin pointed, overlapping vent and reaching anal in a few specimens; anal fin pointed; caudal deeply forked, lobes pointed, upper slightly longer than lower.

Color in alcohol dark brown above, lighter below; each scale with a short, vertical, dark bar, the bars not forming longitudinal stripes; a serrated, dark, mid-lateral stripe from head to base of caudal; usually a large, round precaudal spot three scale rows wide; an intense dark spot just behind opercle; membranes of dorsal and anal fins dusky; other fins colorless.

Eleven specimens, 100 mm. or more in length, were collected in large rivers such as the Kinabatangan, or in cut-off meanders. These habitats have turbid water and silt bottom. An additional 51 smaller fishes were caught in a small, turbid, silt-bottomed forest stream; 232 fishes were collected in pools of a small clear stream over sandy bottoms.

Localities.—Kinabatangan District, Bukit Garam (1), Danau Bilit (2), Danau Bukit Garam (1), Lamag (1), small stream one mile above Sungei Tabalin Besar (10), Deramakot (276), below mouth of Sungei Malubok (1); Labuk and Sugut District, Labuk River (1), Lahad Datu District, Segama River at Segama Estate (2).

Osteochilus vittatus (Valenciennes)

Rohita vittata Valenciennes *in* Cuvier and Valenciennes, 1842, Hist. Nat. Poissons, **16**: 267—Java.

Rohita hasseltii Valenciennes, op. cit., p. 274—Java.

Osteochilus vittatus Guibé and Spillmann, 1957, Bull. Mus. Nat. Hist. Nat., Paris, (2), **29**: 462.

Osteochilus hasseltii (part) Günther, 1868, Cat. Fishes Brit. Mus., **7**: 41; Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 135, figs. 57–58.

Dorsal iv,12–13; pectoral i,14–15; ventral i,8–9; anal iii,5; lateral line scales 32–33; transverse scales 5½/1/6½; predorsal scales 11; circumpeduncular scales 16; gill rakers 8–9+23–24, total 32; head 0.234–0.251; depth 0.285–0.336; eye 0.052–0.065; interorbital 0.106–

0.115; height-length ratio of caudal peduncle 0.848–0.902; standard length 89.6–124.0 mm.; total length 115.0–168.0 mm.

Color in alcohol dark brown above, lighter below; six to nine longitudinal dark stripes formed by a dark spot on each scale; stripe along lateral line more intense than others; an obscure large dark spot at base of caudal.

The three specimens were caught in clear water.

Locality.—Kota Belud District, Tempasuk River (3).

Dangila Valenciennes

Smith (1945) shows that *Dangila* Valenciennes (1842) is antedated by *Labiobarbus* van Hasselt (1823). At the same time Smith notes that *Dangila* has been in general use for a century. To lose a generic name, so widely accepted and used, on non-zoological grounds is to rob zoological nomenclature of a highly important attribute—stability. Furthermore, this particular change, since it will probably lead to the confusion of *Labiobarbus* with *Labeobarbus* Rüppell (1838), a widely used name for another Oriental genus of the same family, also involves the defeat of the principal function of nomenclature, namely, the facilitation of communication. Regardless of the letter of the rules, Smith's proposal violates the pragmatic nature of science and should not be followed.

Dangila sabana,[1] new species. Figure 44.

Holotype.—Chicago Natural History Museum no. 44778, from Danau Bukit Garam, Kinabatangan District. Collected June 18, 1949, by Mr. J. Alan Tubb.

Paratypes.—Thirty-four (CNHM 44779, 44784) from the type locality; 25 others (CNHM 44780–81, 44783, 44785, 68225–27) from the Kinabatangan drainage; 7 (CNHM 44782) from the Segama drainage.

Diagnosis.—A species of *Dangila* distinguished by its low dorsal (iv,18–22) and lateral line (30–36) counts; circumpeduncular scales 19–20; young individuals with longitudinal dark stripes formed by black-tipped scales above the lateral line; a large precaudal spot.

Description (data on holotype in parentheses).—Dorsal iv,18–22 (iv,20) (mean iv,19.6; N=39); pectoral i,16–18 (i,17) (mean i,17.1; N=37); ventral i,8–9 (i,8) (only 1 out of 35 had 9 branched rays);

[1] From Sabah, an earlier name for North Borneo.

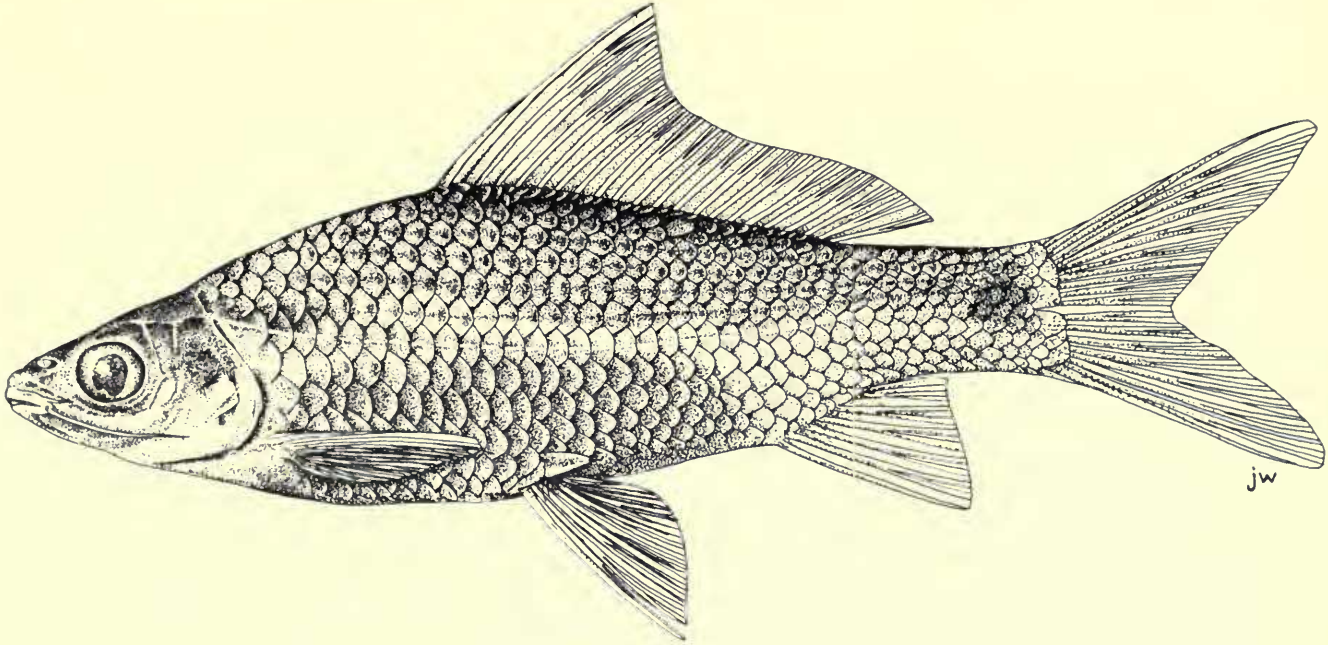

FIG. 44. *Dangila sabana*, new species.

anal iii,5–6 (iii,5) (only 1 out of 35 had 6 branched rays); lateral line scales 30–36 (34) (mean 34.2; N=37); transverse scales (from origin of dorsal to ventral insertion) 5½–6½/1/4½–5½ (5½/1/4½); predorsal scales 10–14 (10) (mean 10.9; N=11); circumpeduncular scales 19–20 (20) (only 5 out of 37 had 19 scales); gill rakers 8–12+36–46 (10+43), total 44–57 (mean total 51.4; N=30); head 0.210–0.283 (0.253) (median 0.251; N=38); depth 0.312–0.384 (0.346) (median 0.346; N=34); snout 0.053–0.080 (0.077) (median 0.067; N=11); eye 0.055–0.088 (0.067) (median 0.067; N=35); interorbital 0.111–0.131 (0.117) (median 0.121; N=27); standard length 57.6–180.0 mm.; total length 77.0–225 mm.

Dorsal profile arched, highest at origin of dorsal fin, concave over occiput; ventral profile weakly convex; head flattened above, snout blunt, with two or three irregular rows of pores usually surmounted by horny tubercles; nostrils separated by valvular flap, in line with upper rim of orbit and tip of snout; rostral barbel reaching below front border of orbit, slightly shorter than diameter of eye; maxillary barbel in small fishes ending slightly behind orbit, in adults reaching posterior border of preopercle or just beyond; eye large; a complete rostral fold overhanging upper lip; mouth inferior, subterminal, curved, gape ending below nostrils; lips separated from jaws by grooves; lips papillate, narrow; post-labial groove broadly interrupted in center; gill openings wide, reaching forward to vertical from hind border of preopercle.

Pectoral fin inserted low on side, pointed, tip narrowly missing base of ventral fin, slightly longer than head; dorsal origin opposite eighth scale of lateral line, margin of fin concave; last simple ray longest, non-osseous, non-denticulate, subequal to pectoral; base of dorsal ending above third or fourth branched anal ray; ventral inserted opposite eleventh to twelfth scale of lateral line, tip reaching anus; margin of anal fin weakly concave, last simple and first branched ray longest, reaching base of caudal; caudal deeply forked, lobes pointed.

Color in alcohol reddish brown, darker above, with five or six longitudinal dark stripes formed by black-tipped scales above lateral line; an obscure precaudal spot; membrane of dorsal and caudal dusky; other fins hyaline.

Measurements of holotype (mm.).—Total length 199; standard length 150; head length 38.0; body depth 52.0; snout 11.5; eye 10.0; interorbital 17.5; longest dorsal ray 39.0; longest pectoral ray 38.5; rostral barbel 8.5; maxillary barbel 20.0.

Comparisons.—*Dangila sabana* is distinguished from its congeners by its low dorsal and lateral line counts. Two species, *leptocheilus* van Hasselt (=*cuvieri* of authors) and *kuhli* Valenciennes, may have as few as 21 branched dorsal rays, but usually have 23 to 27. These two species are further differentiated from *sabana* by their higher lateral line counts (39 or more). *Dangila sumatrana* Bleeker has 22 or 23 branched dorsal rays but has more lateral line scales (37–38) and fewer circumpeduncular scales (16) than *sabana*. *Dangila festiva* Heckel approaches *sabana* in lateral line count (36–38) but has fewer scales around the peduncle (16) and more branched dorsal rays (25–26). Data for these species are from Weber and de Beaufort (1916) and Smith (1945).

Dangila sabana is apparently most closely related to *lineatus* Sauvage (range Thailand and Indo-China). The latter is marked with longitudinal dark lines and has relatively low dorsal and lateral line counts. But the stripes of *lineatus* are much more pronounced and three of them occur regularly below the lateral line, whereas in *sabana* only occasionally do one or two stripes appear on that part of the body. *Dangila lineatus* is also a more slender fish. The ratio of depth to length in five Thailand fishes is 0.301–0.324 (median 0.311). Depth was less than 0.333 in only one-fifth of the *sabana* specimens measured. The following characters of *lineatus* (based on 9 Thailand specimens) also distinguish it from *sabana:* dorsal iv,22–25 (mean iv,23.2); pectoral i,16–17 (mean i,16.5); lateral line scales 34–38 (mean 35.8); circumpeduncular scales 16.

Ecological notes.—All specimens were collected in turbid water in the Kinabatangan and Segama Rivers, or at the mouths of tributaries, or in cut-off meanders.

The alimentary tract is very long and convoluted as in *Osteochilus* and *Lobocheilus*. Smears made from three stomachs contained diatoms, blue-green algae, filamentous algae, small fragments of larger plants, and fine sand grains. A single protozoan was the only animal material identified.

Remarks.—One fish (CNHM 68225) is placed in this species with reservation. It differs from all other specimens in having a shorter head (0.210, the next larger ratio being 0.233), a shorter pectoral, which has a rounded tip, and a much shorter anal, which does not reach the caudal base.

Localities.—Kinabatangan District, Danau Bukit Garam (35), Danau Bilit (6), Danau Duadan (4), Lamag (1), Malapi (5), Dera-

makot (2), tributary of Kinabatangan one mile above Sungei Tabalin Besar (1); Lahad Datu District, Segama River at Segama Estate (7).

Garra borneensis (Vaillant). Figure 45.

Discognathus borneensis Vaillant, 1902, Notes Leyden Mus., **24:** 91, figs. 25–26 —Bluu River, Borneo; Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3:** 228, fig. 92.

Garra borneensis Fowler, 1905, Proc. Acad. Nat. Sci. Philadelphia, **57:** 482.

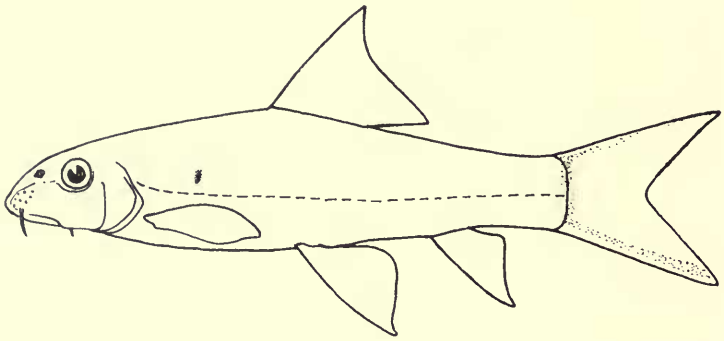

FIG. 45. *Garra borneensis.*

Dorsal iii,8 (N=16); pectoral i,13–15 (mean i,14.6; N=16); ventral i,7–8 (only one out of 16 had 7 branched rays); anal ii,5 (N=16); lateral line scales 28–30 (mean 28.3; N=16); transverse scales 3½–4½/1/4½–5; predorsal scales 8–11 (mean 9.5; N=16); circumpeduncular scales 12 (N=10); gill rakers 0–1+5–8, total 6–9 (mean total 7.7; N=4); head 0.220–0.276 (median 0.231; N=16); depth 0.193–0.233 (median 0.215; N=16); snout 0.089–0.113 (median 0.104; N=8); eye 0.047–0.100 (median 0.053; N=16); interorbital 0.096–0.134 (median 0.114; N=10); height-length ratio of caudal peduncle 0.668–0.863 (median 0.728; N=8); standard length 19.3–105.1 mm.; total length 26.0–145.0 mm.

Color in alcohol brownish, dark above, lighter below; each scale on sides with a vertical dark bar at its base; a dark brown spot present or absent on the scales immediately above and below the fifth scale on the lateral line; dorsal, pectoral, ventral, and anal rays dusky; a dark submarginal streak on the lower lobe of the caudal and a similar indistinct one on the upper lobe.

Three females with enlarged ova measured 90.6–95.7 mm. One male with enlarged gonads measured 92.7 mm.

Specimens of this species were collected from small streams (about 2 meters wide) as well as large rivers (Tempasuk and Kinabatangan) with clear or muddy waters, and over gravel or silt bottoms.

The gut is very long and convoluted. Only one smear was made from material in the anterior part of the gut and it contained diatoms, fragments of larger plants, and fine sand grains.

Local names.—"Bat-duan" (Dusun) and "Tunjungon" (Orang Sungei). Apparently no distinction is made between this species and the following one.

Localities.—Kinabatangan District, small stream one mile above Sungei Tabalin Besar (7), Deramakot (6), Kinabatangan River below mouth of Sungei Malubok (35); Kota Belud District, Tempasuk River (13).

Epalzeorhynchus kalliurus Smith. Figure 46.

Epalzeorhynchos kalliurus Smith, 1945, Bull. U. S. Nat. Mus., no. 188, p. 264, fig. 51—Mekong River, Thailand.

Dorsal iii,8 (N=12); pectoral i,12–15 (mean i,13.8; N=12); ventral i,8 (N=12); anal iii,5 (N=12); lateral line scales 30–33 (mean 31.3; N=12); transverse scales 4½/1/5½; predorsal scales 8–10 (mean 9.0; N=12); circumpeduncular scales 16 (N=10); gill rakers 4–5+16–17, total 20–22 (mean total 21.0; N=8); head 0.211–0.294

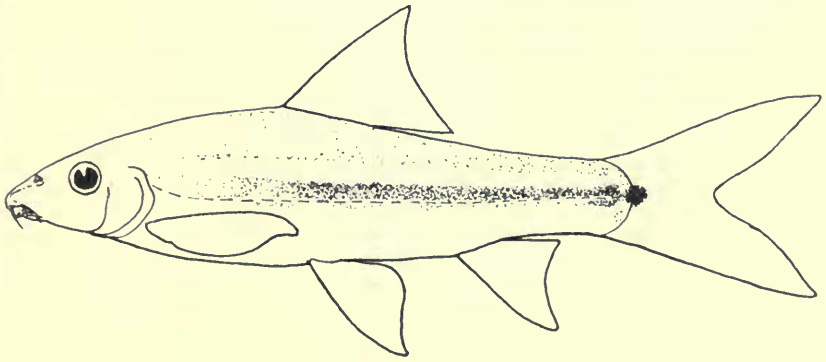

FIG. 46. *Epalzeorhynchus kalliurus.*

(median 0.232; N=14); depth 0.207–0.285 (median 0.242; N=13); snout 0.070–0.092 (median 0.081; N=10); eye 0.058–0.085 (median 0.064; N=10); interorbital 0.093–0.111 (median 0.101; N=10);

height-length ratio of caudal peduncle 0.554–0.735 (median 0.622; N=9); standard length 23.4–80.2 mm.; total length 30.5–109.7 mm.

Color in alcohol yellowish brown above, lighter below; an intense dark stripe from head to base of tail ending in a distinct caudal spot; the mid-lateral stripe separated from the dark dorsal coloration by a yellowish stripe; fin colorless.

Enlarged ova were found in females ranging in length from 56.4 to 72.0 mm.

Specimens were collected in a small clear stream having a sand and gravel bottom; in a small, turbid, silt-bottomed stream; and on a gravel bar in the Kinabatangan River. The extremely long and convoluted digestive tracts containing finely divided particles are characteristic of detritus feeders. Smears made from two stomachs contained blue-green and filamentous algae, small fragments of larger plants, and fine sand grains.

These fishes from the Kinabatangan drainage agree with Smith's description closely. They differ from *kalliurus* only in the intensity of the mid-lateral stripe, in lacking the dark band of the dorsal fin, and in having 30–33 scales instead of 28 as in the type. The coloration is distinctly that of *kalliurus* Smith rather than that of the previously known Bornean species, *kalopterus* Bleeker. The latter also differs from the present series in lateral line counts (34–36) and in the larger number of transverse scales (5½ to dorsal).

Local names.—"Bat-duan" (Dusun) and "Tunjungon" (Orang Sungei).

Localities.—Kinabatangan District, Danau Bukit Garam (2), Danau Duadan (1), small stream one mile above Sungei Tabalin Besar (34), Deramakot (11), Kinabatangan River below mouth of Sungei Malubok (55).

Paracrossochilus acerus,[1] new species. Figure 47.

Crossochilus vittatus (part) Boulenger, 1894, Ann. Mag. Nat. Hist., (6), **13**: 247—Senah, Poeh and Tagora River, Sarawak.

Paracrossochilus vittatus (part) Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 227.

Holotype.—Chicago Natural History Museum no. 68240, an adult female (68.5 mm. in standard length) from Sungei Dapu, a small tributary of the Baleh River, Third Division, Sarawak. Collected August 8, 1956, by R. F. Inger.

[1] From *a*, "without," and *ceras*, "horn," referring to the absence of the large rostral tubercles.

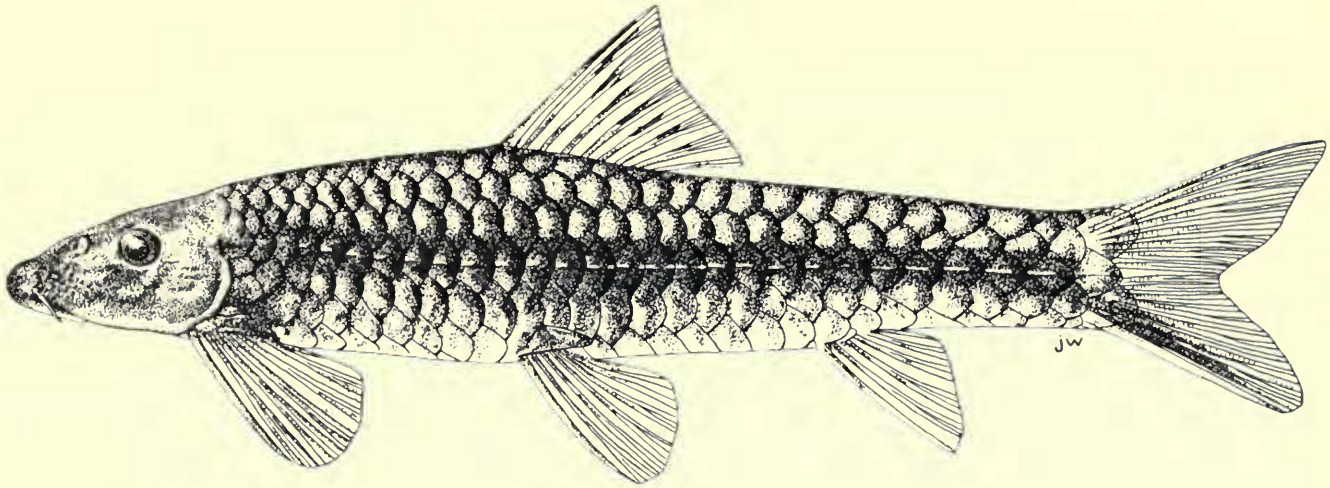

FIG. 47. *Paracrossochilus acerus*, new species.

Paratypes.—Sarawak: CNHM 68241 (450), collected with the holotype; CNHM 68242 (101), from an unnamed tributary of the Baleh River, 10 kilometers from the type locality; CNHM 68243 (2), Sarawak Museum unnumbered (16), from the headwaters of the Baleh River, Third Division; Sarawak Museum unnumbered (3), from Meligong, Akah River, Fourth Division; CNHM 45854 (2), from Lawas, and CNHM 45855 (2), from Pa Brayong, Fifth Division.

North Borneo: CNHM 44783 (2), from Tempasuk River, Kota Belud District; CNHM 68244 (2), from Sungei Membikit, Keningau District; CNHM 68245 (6), from Sungei Kaingeran, Tambunan District.

Diagnosis.—A species of *Paracrossochilus* without paired large, yellowish, laterally directed conical tubercles at the tip of the snout; a patch of small, whitish tubercles on the side of the snout; maxillary barbel far behind mouth opening; black lateral stripe one scale row wide; tip of ventral fin separated from anal by 3–4 scales.

Description (data on holotype in parentheses) —Dorsal iii,8–9 (iii,8) (only 1 out of 21 had 9 branched rays); pectoral i,14–16 (i,15) (mean i,15.0; N=21); ventral i,8 (i,8) (N=21); anal iii,5 (iii,5) (N=21); lateral line scales 26–29 (27) (mean 27.0; N=21); transverse scales 3½/1/3½ (N=17); predorsal scales 9–11 (11) (mean 10.4; N=19); circumpeduncular scales 10 (N=15); gill rakers about 12, rudimentary; head 0.191–0.270 (0.195) (median 0.219; N=20); depth 0.186–0.226 (0.195) (median 0.203; N=20); snout 0.085–0.112 (0.087) (median 0.092; N=14); eye 0.047–0.067 (0.051) (median 0.051; N=14); interorbital 0.095–0.111 (0.096) (median 0.101; N=14); height-length ratio of caudal peduncle 0.550–0.820 (0.699) (median 0.699; N=13); standard length 22.6–73.0 mm. (68.5); total length 34.2–93.8 mm. (88.8 mm.).

Body fusiform anteriorly, becoming compressed posteriorly; dorsal profile convex, deepest just before dorsal origin; ventral profile straight, under side of head flat; nostrils slightly closer to eyes than to tip of snout; nostrils separated by valvular flap, the anterior nostril with a short tube; eye in posterior half of head; interorbital flat; mouth inferior, overhung by broad papillose upper lip; upper lip with longitudinal rows of papillae, the lip split between rows; upper lip continuous with lower by means of a posterior prolongation reaching well behind the level of the mouth opening; lower lip papillose, broad, overhanging lower jaw; rostral barbels much less than half diameter of eye; maxillary barbel subequal to rostral, located at posterior corner of juncture between upper and lower lip.

Dorsal fin emarginate, the first branched ray the longest; pectoral fin horizontal, low on side, pointed, the fourth branched ray reaching the farthest; tip of pectoral separated from ventral by 2 to 3½ scales; ventral fin inserted below base of dorsal, truncate, separated from anal by 3 to 4 scales; anal fin emarginate, inserted behind last dorsal ray; caudal deeply forked, lobes pointed, subequal.

Color in alcohol dark above, lighter below; a black longitudinal stripe occupying lateral line scales or upper four-fifths of lateral line scales and lower corners of scales above the row, but never wider than one scale row; scales above mid-lateral stripe brownish, with dark posterior edges; scales below lateral stripe dusky, the density of chromatophores gradually decreasing ventrally; belly yellowish without markings; dorsal fin with a narrow subterminal black band formed by black bars on the anterior edge of each ray; anal fin usually with a similar though narrower dark band; pectoral and ventral dusky above; caudal with submarginal black stripe on each lobe, the one on the lower lobe much wider and continuous with the mid-lateral stripe.

Both males and females have patches of small tubercles on the sides of the snout. Enlarged ova (ca. 1.3 mm.) were found in females ranging in size from 49.0 to 73.0 mm. Males with enlarged gonads measured 48.3–69.8 mm.

Habitat.—All specimens were collected in small (2 meters wide) to large streams (about 20 meters wide) having clear water and rocky or gravel bottoms.

Comparisons.—In the original description of *Crossochilus rittatus*, Boulenger (1894) stated that the male had a large horny conical tubercle on each side of the snout. As his description was based on "numerous specimens," the implication is that some of his specimens lacked the peculiar structure. Weber and de Beaufort (1916) stated that *rittatus* may or may not have these large tubercles. Ninety specimens of *rittatus*, that is, fishes having a pair of large conical tubercles at the end of the snout, were collected by us with the 550 specimens of *acerus*. Both of these samples include mature males and females, as determined by examination of the gonads. Therefore, the differences between fishes having or lacking the large rostral tubercles cannot be sexual in origin. Females of *rittatus* have smaller rostral "horns" than the males.

Both species have lateral black stripes, but that of *rittatus* is at least 1½ and usually 2 scale rows wide. The stripe of *acerus* is never more than one scale row wide. The scales on the caudal peduncle

immediately below the lateral stripe have no chromatophores in *vittatus* whereas those of *acerus* have a dusting of chromatophores. The rostral barbel in *vittatus* is more than half the eye diameter and is about twice the length of the barbel in *acerus*. The maxillary barbel in *vittatus* comes off the lip at the level of the mouth opening and is therefore more anterior in position than that of *acerus*. Other differences between these species are shown in Table 8.

TABLE 8.—Frequency Distribution of *Paracrossochilus vittatus* and *P. acerus* with Respect to Four Characters

	Predorsal Scales			Circumpeduncular Scales		
	9	*10*	*11*	*8*	*9*	*10*
vittatus	2	9		4	1	6
acerus	1	9	9			15

	Scales between Tip of Pectoral and Origin of Ventral					Scales between Tip of Ventral and Origin of Anal					
	1½	*2*	*2½*	*3*	*3½*	*1½*	*2*	*2½*	*3*	*3½*	*4*
vittatus	2	7	3	1		1	4	6	2		
acerus		3	2	9	3		1	1	9	4	2

Localities.—Sarawak: Third Division, headwaters of Baleh River (573); Fourth Division, Meligong, Akah River (2); Fifth Division, Lawas (2), Pa Brayong (2). North Borneo: Keningau District, Sungei Membikit (2); Kota Belud District, Tempasuk River (2); Tambunan District, Sungei Kaingeran (6).

GASTROMYZONTIDAE

KEY TO SPECIES FROM NORTH BORNEO

1A. Ventral fins united under belly (fig. 48, A) ..... *Gastromyzon borneensis.*
B. Ventral fins separated (fig. 48, B) ..... 2.
2A. Nasal barbels present (fig. 48, C) ..... *Glaniopsis hanitschi.*
B. Nasal barbels absent ..... 3.
3A. Gill opening extending on to ventral surface anterior to the pectoral fin (fig. 48, D) ..... *Parhomaloptera microstoma.*
B. Gill opening restricted to side of body ..... 4.
4A. Gill opening reaching pectoral base (fig. 48, E) ..... *Protomyzon griswoldi.*
B. Gill opening not reaching pectoral base (fig. 48, F) ..... 5.
5A. Posterior lip not papillose (fig. 48, G) ..... *Protomyzon aphelocheilus.*
B. Posterior lip papillose (fig. 48, H) ..... 6.

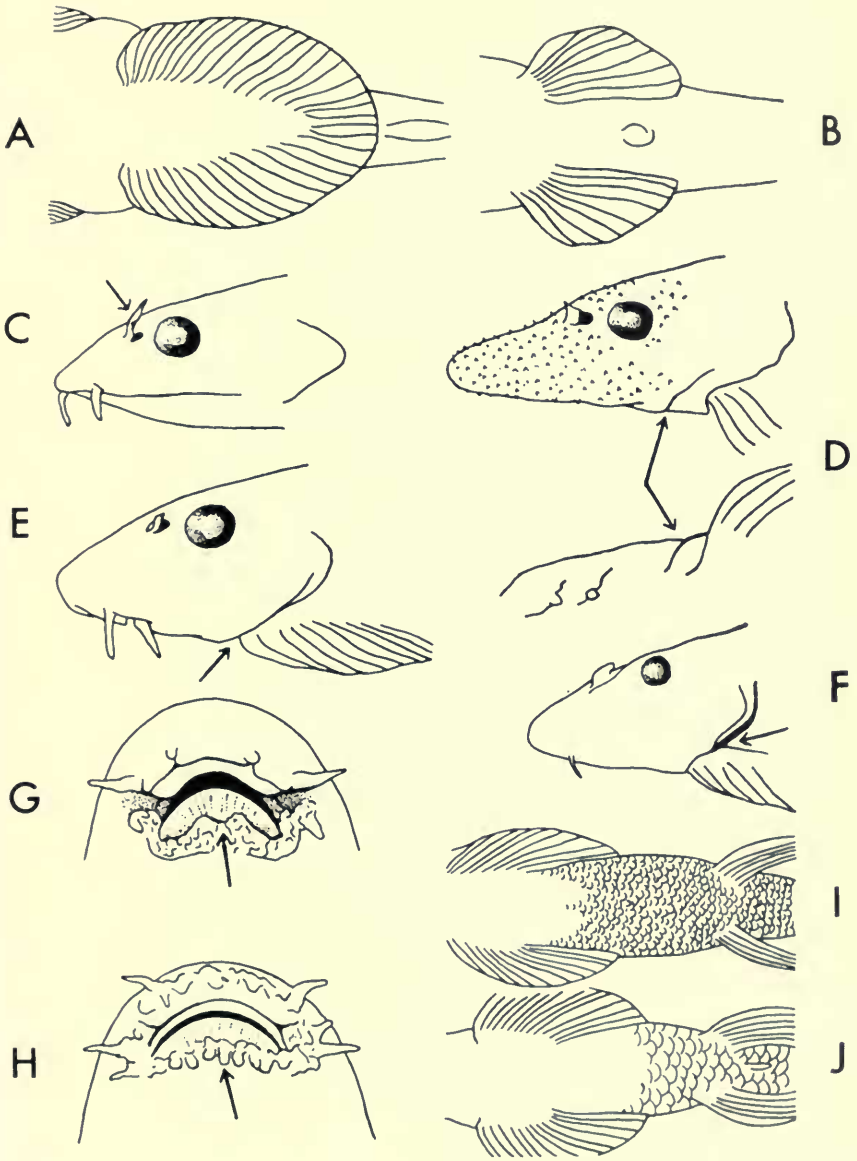

FIG. 48. Key to species of Gastromyzontidae.

6A. Belly scaled as far forward as insertion of pectoral fin (fig. 48, I). *Protomyzon whiteheadi.*

B. Ventral scales mid-ventrally widely separated from level of pectoral insertion (fig. 48, J) ..... *Protomyzon borneensis.*

Gastromyzon borneensis Günther. Figure 49.

Gastromyzon borneensis Günther, 1874, Ann. Mag. Nat. Hist., (4), **14**: 454—Mengalong River, North Borneo; Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 3, fig. 1; Hora, 1932, Mem. Indian Mus., **12**: 322, pl. 12, fig. 12; 1950, Rec. Indian Mus., **48**, pt. 1, pp. 53, 56; Silas, 1953, Rec. Indian Mus., **50**, pt. 2, p. 240; Inger and Chin, 1961, Copeia, **1961**: 171, figs. 4A, 5.

Dorsal iii,7–9 (mean iii,7.7; N=14); pectoral i,23–26 (mean i,24.4; N=19); ventral i,18–21 (mean i,18.9; N=17); anal I,i,4–5 (mean I,i,4.4; N=14); lateral line pores 51–58 (mean 54.4; N=22); head 0.243–0.306; head width at anterior base of pectoral 0.237–0.329 (median 0.295; N=22); eye 0.038–0.059 (median 0.048; N=22); width of gill opening 0.042–0.070 (median 0.053; N=22); standard length 20.6–72.2 mm.; total length 25.9–91.1 mm.

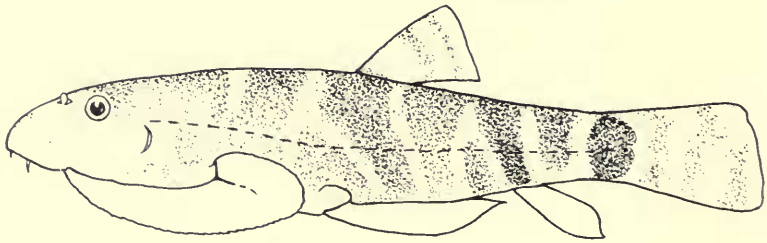

FIG. 49. *Gastromyzon borneensis.*

This species, adapted to life in torrents, has previously been reported only from the mountainous axis of central and northwestern Borneo. Five of the present sample were collected in the coastal fringe of northwestern Borneo at an elevation of less than 100 meters. Twenty-two were collected in eastern North Borneo within 200 meters of sea level. The habitat—rocky rapids—is provided in this region by the rugged characters of the landscape. As much of eastern North Borneo has the same rough topography, *Gastromyzon* presumably is widely distributed there.

Gastromyzon grazes on the algae growing on the rocks to which it clings. Smears made from the fore part of the long, convoluted gut were full of diatoms and blue-green and filamentous algae.

Local names.—"Rokot" or "Rogot" (Dusun).

Localities.—Kinabatangan District, Sungei Gaja (1), Deramakot (21); Kota Belud District, Tempasuk River (5); Kudat District, Bongon (1); Ranau District, Mount Kina Balu (Vaillant, 1893), Bundu Tuhan (6); Sipitang District, Mengalong River (Günther, 1874); Tambunan District, Sungei Purutan (9), Sungei Kaingeran (5).

Glaniopsis hanitschi Boulenger. Figure 50.

Glaniopsis hanitschi Boulenger, 1899, Ann. Mag. Nat. Hist., (7), **4**: 228—Mount Kina Balu, North Borneo; Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 5, fig. 2; Hora, 1932, Mem. Indian Mus., **12**: 267; Hora and Jayaram, 1950, Rec. Indian Mus., **48**: 85; Silas, 1953, Rec. Indian Mus., **50**, pt. 2, p. 221.

Dorsal ii–iii,6 (N=7); pectoral i,10–13 (mean i,11.7; N=7); ventral i,7 (N=7); anal ii–iii,5 (N=7); predorsal scales ca. 53 (N=3); lateral line scales 92–121 (median 95; N=6); head 0.180–0.226 (median 0.206; N=6); depth 0.129–0.153 (median 0.145; N=4); width of head at anterior base of pectorals 0.153–0.159; width of mouth 0.073–0.075; snout 0.072–0.084; eye 0.021–0.027; interorbital 0.087–0.094; standard length 37.0–64.0 mm.

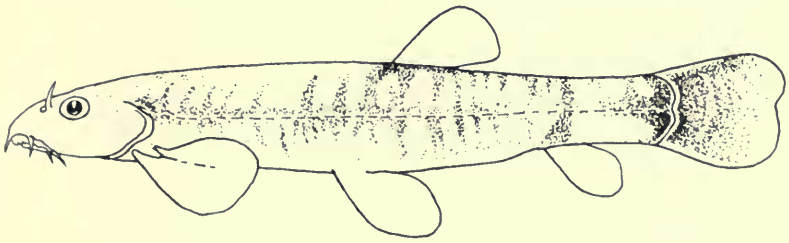

FIG. 50. *Glaniopsis hanitschi.*

Specimens from Sungei Membikit, Keningau, had incomplete lateral lines.

Mature males had small spinose tubercles on the snout, the side of the head, the chin, and the dorsal surface of the pectoral rays. Mature females lacked tubercles.

Color grayish brown with irregular, vertical, dark spots on sides of body and usually dark crossbars on back.

This fish lives in hill streams with clear water, rapid current, and sand and rock bottoms.

Local names.—"Lauos" (Dusun) and "Melugu" (Orang Sungei).

Localities.—Keningau District, Sungei Membikit (3); Ranau District, Bundu Tuhan (3), Mount Kina Balu (Boulenger, 1899), Brakakis (1).

Parhomaloptera microstoma (Boulenger). Figure 51.

Homaloptera microstoma Boulenger, 1899, Ann. Mag. Nat. Hist., (7), **4**: 228—Akar River, Sarawak.

Parhomaloptera microstoma Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 20, fig. 5; Hora, 1932, Mem. Indian Mus., **12**: 313, pl. 12, fig. 7; 1952, Proc. Nat. Inst. Sci. India, **18**: 417, fig. 2B; Silas, 1953, Rec. Indian Mus., **50**, pt. 2, p. 225.

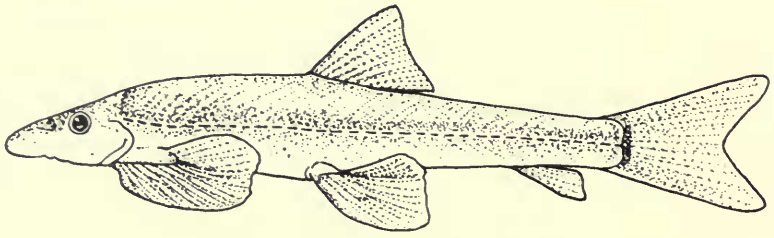

FIG. 51. *Parhomaloptera microstoma.*

Dorsal ii,7–8 (mean ii,7.4; N=10); pectoral i,16–18 (mean i,16.6; N=10); ventral i,9–11 (mean i,10; N=10); anal i,5–6 (mean i,5.2; N=10); lateral line pores 90–103; head 0.177–0.206 (median 0.190; N=9); depth 0.139–0.153 (median 0.146; N=8); snout 0.091–0.108 (median 0.095; N=8); eye 0.025–0.035 (median 0.031; N=9); interorbital 0.082–0.101 (median 0.091; N=9); standard length 34.0–57.3 mm.; total length 43.5–74.8 mm.

Color in alcohol dark purplish brown above, immaculate yellow below; an indistinct dark streak along lateral line; pectoral and ventral fins dark above, the pigment concentrated along the rays; dorsal and anal rays dark; caudal dark purplish brown.

The descriptive notes are based on one specimen from North Borneo and 15 specimens from Sarawak.

According to Weber and de Beaufort (1916), there are 5 or 6 unbranched rays in the pectoral fin. Hora (1932), however, pointed out that there is actually but one simple pectoral ray. Our observations coincide with those of Hora.

Locality.—Ranau District, Bundu Tuhan (1).

Protomyzon griswoldi (Hora and Jayaram). Figure 52.

Progastromyzon griswoldi Hora and Jayaram, 1951, Rec. Indian Mus., **49**: 192, fig. 1—Mount Kina Balu, North Borneo; Silas, 1953, Rec. Indian Mus., **50**, pt. 2, p. 239.

The genus *Progastromyzon* was differentiated from *Protomyzon* solely on the basis of the mouth. The difference in width of gape mentioned by Hora and Jayaram (1951b) and Silas (1953) is bridged by the species available to us. In *aphelocheilus* the gape (in thousandths of standard length) varies from 52 to 72, in *borneensis* from 60 to 73, in an unnamed species from central Sarawak from 73 to 88, in *griswoldi* from 98 to 124. In some species the rostral fold is deep, in some it is shallow. Considering the step-wise gradation from the condition in *griswoldi* to the condition in *whiteheadi* and the range of variation in mouth parts within the genus *Gastromyzon*, we do not recognize the genus *Progastromyzon*.

The common name "Borud" (Dusun and Orang Sungei) is applied to all species of this genus.

Dorsal ii,7–8 (only 3 of 14 had 8 branched rays); pectoral i,19–24 (mean i,20; N=13); ventral i,8–9 (mean i,8.2; N=13); anal ii,5–6 (mean ii,5.2; N=10); predorsal scales 38–45 (mean 40.9; N=12); lateral line pores 67–72 (mean 68.7; N=11); lateral line scales 72–80 (mean 76.2; N=12); head 0.188–0.257 (median 0.204; N=16); depth 0.149–0.198 (median 0.184; N=8); width of head at anterior base of pectorals 0.160–0.189 (median 0.170; N=15); width of mouth 0.098–0.124 (median 0.106; N=15); eye 0.030–0.052 (median 0.032; N=16); standard length 24.9–68.0 mm.; total length 31.8–89.1 mm.

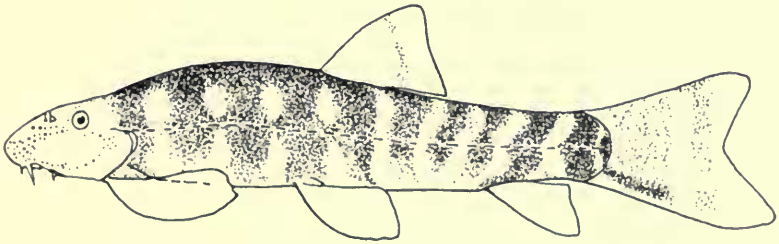

FIG. 52. *Protomyzon griswoldi.*

Mouth opening about two-thirds of width of head; gill opening restricted to lateral surface of body, the lower corner just reaching the base of the pectoral; belly scaleless or scales deeply embedded in skin in posterior half.

Color in alcohol dark purplish brown, immaculate cream-colored below; sides of body with 6–8 narrow vertical light bars, becoming wider in posterior half of body; bars on caudal peduncle in some specimens fused across the dark area; dorsal and pectoral fin rays dusky, membrane colorless; ventral and anal colorless or with anterior rays dusky; caudal with dark spots or vertical bars, the pigment confined to the rays.

The specimen from Mount Kina Balu has more pectoral rays (i,24) than do those from Sungei Membikit, Keningau (i,19–21).

The Membikit specimens showed distinct secondary sexual characters: the mature males (54–70 mm.) had nuptial tubercles of various sizes on the head and on the anterior 4 or 5 rays of the pectoral fins. The larger tubercles were found at the end of the snout and in a ring around the eye and in a curved line following the posterior margin of the preopercle. Smaller tubercles were found on the top of the head, and on the cheek and opercle. A few short vertical rows of sensory papillae occurred anteriorly on the cheek in an area between the nostril and the mouth. Mature females (48–66 mm.) had a few indistinct tubercles on the snout and the side of the head.

This species lives in riffles and pools (generally less than one meter deep) of clear streams over rock or silt bottoms. It has the long convoluted gut characteristic of the detritus feeders.

Localities.—Keningau District, Sungei Membikit (14); Ranau District, Bundu Tuhan (1), Mount Kina Balu (Hora and Jayaram, 1951b); Tawau District, Kalabakan, Sungei Tawan (2).

Protomyzon aphelocheilus,[1] new species. Figure 53.

Holotype.—Chicago Natural History Museum no. 68166. An adult female (41.6 mm. standard length) from Sungei Kaingeran, Tambunan District, North Borneo. Collected July 25, 1959, by P. K. Chin.

Paratypes.—CNHM 68167 (13) from the type locality.

Diagnosis.—A small *Protomyzon* having a narrow, lunate mouth with the lower lip not papillate; the belly scaled in a narrow band anterior to ventrals; and more than 65 pores in the lateral lines.

Description (data on holotype in parentheses).—Dorsal ii,7 (ii,7) (N=10); pectoral i,21–22 (i,21) (mean i,21.5; N=10); ventral i,8–9

[1] From *apheles* (Gr.), "smooth," or "simple," and *cheilos* (Gr.), "lip."

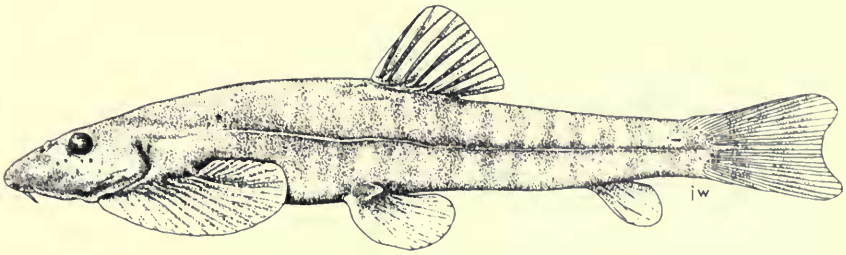

FIG. 53. *Protomyzon aphelocheilus*, new species.

(i,9) (mean i,8.4; N=10); anal i,5 (i,5) (N=10); lateral line pores 66–84 (79) (mean 73.9; N=10); predorsal scales 44–53 (mean 48.0; N=8); head 0.209–0.252 (0.209), decreasing with increase in standard length; depth 0.149–0.175 (0.175) (median 0.166; N=10); snout 0.088–0.119 (0.096) (median 0.103; N=10); eye 0.031–0.046 (0.033), decreasing with increase in standard length; standard length 18.0–41.6 mm. (41.6); total length 22.5–51.0 mm. (51.0).

Dorsal profile strongly convex, rising from tip of snout to just before dorsal origin, then sloping to caudal peduncle; ventral profile straight; body fusiform, compressed behind dorsal, flat below; head broadly rounded; nostrils approximated, separated by valvular flap; eye–nostril distance less than eye diameter; eye in posterior half of head; mouth ventral, subterminal; mouth lunate, width about one-third of head width; a rostral fold barely overhanging upper lip; four barbels arising from rostral fold, the median pair half as long as the lateral barbels; rostral fold smooth between barbels; smooth upper lip overhanging horny jaw; deep transverse groove separating upper and lower lips; lower lip notched but not papillated, not overhanging lower horny jaw; a short barbel at corner of posterior lip; gill opening restricted to side of head, widely separated from base of pectoral; gill opening equaling eye diameter; a deep groove from lower corner of gill opening to base of pectoral fin.

Scales on ventral surface embedded in skin in a broad crescent anterior to ventrals; width of crescent in mid-line equal to half the distance between ventral and pectoral bases.

Pectoral fins inserted low on sides, origin of insertion below eye; pectoral horizontal except the last quarter, which lies flat against sides of body; pectoral widely separated from ventral; ventral inserted at beginning of second half of body, separated from anal fin by length of ventral fin, margin of ventral rounded; a small scaleless

supraventral flap; dorsal inserted over end of ventral base; anal origin separated from end of dorsal base by more than length of dorsal base; anal rays not reaching caudal; caudal fin feebly emarginate.

Color in alcohol dark purplish brown with 12–20 dark vertical bars on body; head without markings; ventral surface without markings anterior to caudal peduncle; pectoral and dorsal rays dusky; caudal with dark vertical bars; other fins colorless.

Four females (33.4–41.6 mm.) contained enlarged ova, each about 2 mm. in diameter.

Remarks.—This series was collected in a clear, swift, rocky-bottomed stream.

Comparisons.—*Protomyzon aphelocheilus* differs from *griswoldi* in standard length (female *griswoldi* with ripe ova 50–65 mm., *aphelocheilus* 33–42 mm.), in having a narrower mouth (0.10–0.12 in *griswoldi*, 0.05–0.07 in *aphelocheilus*), and in having the gill opening widely separated from the base of the pectoral. The new species differs from *whiteheadi* in having a smooth rather than a papillated posterior lip, and a much more restricted scaled area on the belly; in *whiteheadi* the entire ventral surface behind the pectoral is scaled. *Protomyzon aphelocheilus* differs from *borneensis* in having a smooth rather than a papillated posterior lip and more pores in the lateral line (66–84 in *aphelocheilus*, 56–64 in *borneensis*).

Local name.—"Rokot" (Dusun).

Locality.—Tambunan District, Sungei Kaingeran (14).

Protomyzon whiteheadi (Vaillant)

Homaloptera whiteheadi Vaillant, 1893, Nouv. Arch. Mus. Hist. Nat., (3), **5**: 92, pl. 1, fig. 2—Mount Kina Balu, North Borneo; Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 13.

Protomyzon whiteheadi Hora, 1932, Mem. Indian Mus., **12**: 306; Hora and Jayaram, 1951, Rec. Indian Mus., **48**, pt. 2, p. 65, figs. 3–4; Silas, 1953, Rec. Indian Mus., **50**, pt. 2, p. 238.

Dorsal iii,6–7 (only one with 6; N=12); pectoral i,18–23 (mean i,21.0; N=14); ventral i,7–9 (mean i,7.9; N=14); anal iii,5; lateral line scales 60–77 (mean 66.7; N=11); predorsal scales about 40; head 0.216–0.243 (median 0.228; N=10); depth 0.130–0.162 (median 0.150; N=5); snout 0.088–0.100 (median 0.097; N=4); eye 0.054–0.068 (median 0.060; N=4); interorbital 0.091–0.111 (median 0.108; N=4); standard length 14.5–41.0 mm.; total length 17.5–45.5 mm.

Width of mouth one-third to three-sevenths of head width.

Coloration varies from brownish with a dark mid-lateral streak (as described by Vaillant, 1893) to a pattern consisting of 9 to 12 bold, dark, vertical bars. The caudal fin usually has two dark vertical bars.

Hora and Jayaram (1951a) and Silas (1953) credit *whiteheadi* with 6–7 branched anal and 9–10 branched ventral rays. Their material is from Kina Balu. The present series comes from within 75 km. of that peak; all specimens have 5 branched anal rays and only one has 9 branched ventrals.

This species lives in clear hill streams with rock, gravel, or sand bottoms.

Local name.—"Rokot" (Dusun).

Localities.—Keningau District, Sungei Apin-apin (3); Ranau District, Kampong Brakakis (12), Bundu Tuhan (2), Mount Kina Balu (Vaillant, 1893).

Protomyzon borneensis Hora and Jayaram

Protomyzon borneensis Hora and Jayaram, 1951, Rec. Indian Mus., **49**, pt. 2, p. 193, fig. 2—Mount Kina Balu, North Borneo; Silas, 1953, Rec. Indian Mus., **50**, pt. 2, p. 238.

Dorsal i–ii,6–7 (only one with 6 branched rays; N=7); pectoral i,19–23 (mean i,21.4; N=7); ventral i,8–9 (only one with 9 branched rays; N=7); anal i–ii,4–5 (only one with ii,4; N=7); lateral line pores 57–64 (mean 60.4; N=7); predorsal scales 34–45; head 0.207–0.236 (median 0.226; N=7); depth 0.150–0.186 (median 0.180; N=7); snout 0.076–0.111 (median 0.090; N=7); eye 0.040–0.048 (median 0.045; N=7); interorbital 0.096–0.116 (median 0.103; N=7); standard length 21.2–35.1 mm.; total length 24.0–43.7 mm.

Mouth ventral, subterminal, its width about one-third of head width; rostral fold papillate and partly overhanging smooth upper lip; upper lip completely overhanging upper jaw; a deep transverse groove separating upper and lower lips; lower lip papillate across anterior border, not overhanging horny lower jaw; three barbels at each corner of the mouth; barbels not much longer than labial papillae.

Cycloid scales embedded in ventral skin in a lunate-shaped band anterior to ventrals, the median width of the band of scales equaling one-fourth of the distance between ventral and pectoral fins.

In alcohol color of head brown or purplish brown; about 12 dark vertical bands on body; ventral surface uniformly pale yellow.

Contrary to the description of Hora and Jayaram, the gill opening does not reach the base of the pectoral. The gill opening is about equal to the diameter of the eye; from its lower corner a deep groove extends to the base of the pectoral fin. This description applies to our series as well as to the holotype, which we have examined.

One female (31.6 mm.) was swollen with ova which were 1 mm. in diameter.

This series was caught in a clear, rocky stream.

Local name.—"Rokot" (Dusun).

Localities.—Ranau District, Mount Kina Balu (Hora and Jayaram, 1951b); Tambunan District, Sungei Kaingeran (9).

HOMALOPTERIDAE

Homaloptera weberi Hora

Homaloptera weberi Hora, 1932, Mem. Indian Mus., **12**: 284, pl. 11, fig. 2; Silas, 1951, Jour. Zool. Soc. India, **3**: 10; 1953, Rec. Indian Mus., **50**, pt. 2, p. 193.

Dorsal iii,7–8 (mean iii,7.2; N=5); pectoral v–vii,9–11 (mean of branched rays 10.5; N=6); ventral ii,8 (N=6); anal ii,5 (N=5); lateral line pores 42–46 (mean 43.8; N=6); predorsal scales 17; head 0.248–0.276 (median 0.254; N=5); width of head measured anterior to pectoral base 0.178–0.191 (median 0.179; N=5); depth 0.140–0.146 (median 0.142; N=5); eye 0.063–0.080 (median 0.068; N=5); snout 0.093–0.107 (median 0.095; N=5); interorbital 0.059–0.066 (median 0.062; N=5); least height of caudal peduncle about twice in its length; standard length 21.0–27.9 mm.; total length 26.8–35.4 mm.

Interorbital width slightly less than diameter of eye; lower corner of gill opening reaching ventral surface around anterior base of pectoral. Origin of dorsal situated behind origin of ventral and slightly nearer to base of caudal than to tip of snout. Ventral surface scaleless.

Color in alcohol pale brownish; 5–6 indistinct crossbars on body; 4 short dark longitudinal streaks on top of snout.

This species inhabits turbid streams having deep mud bottoms and clear hill streams with rapid flow and rock bottoms. An immature aquatic insect was found in one stomach.

Localities.—Kinabatangan District, small tributary of Kinabatangan River one mile above mouth of Sungei Tabalin Besar (3), Deramakot (3).

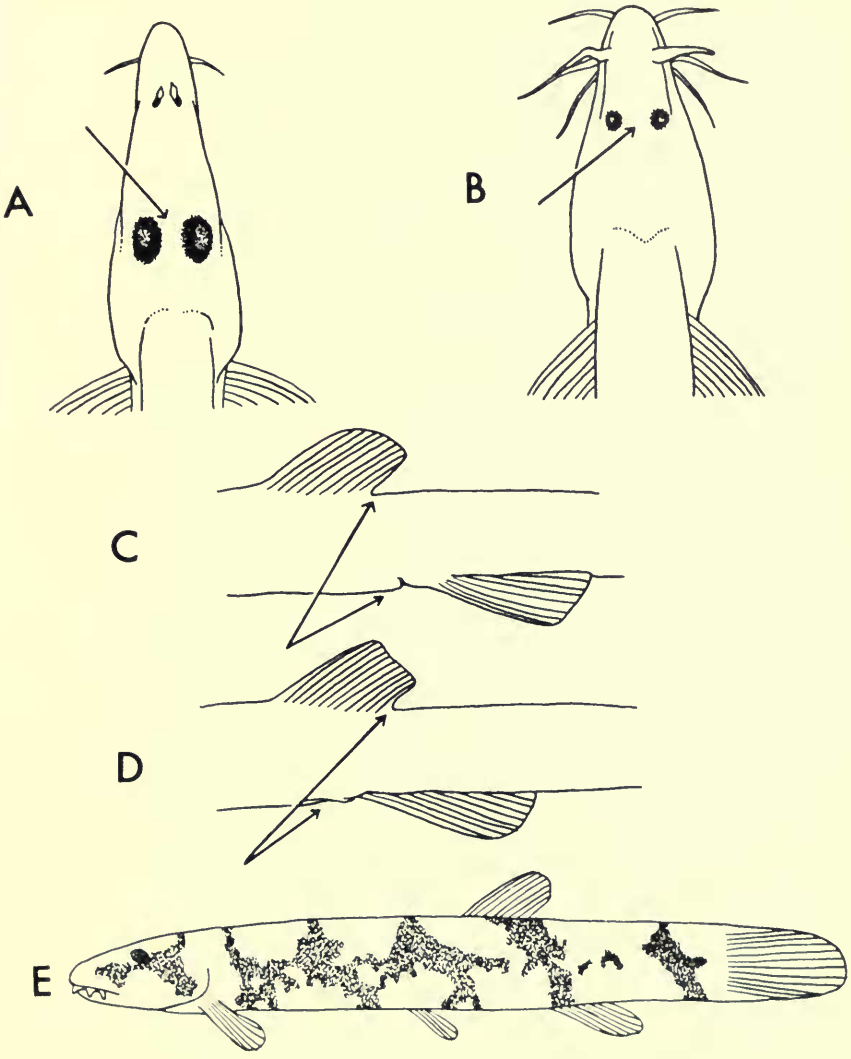

FIG. 54. Key to species of Cobitidae.

COBITIDAE

KEY TO SPECIES FROM NORTH BORNEO

1A. Eyes very close together, interorbital much less than diameter of eye (fig. 54, A) ..... *Acanthopsis choirorhynchus.*

B. Interorbital equal to or wider than diameter of eye (fig. 54, B) ..... 2.

2A. Nasal barbel present (fig. 54, B); body depth more than ten times in total length ..... 3.

B. Nasal barbel absent; body depth less than ten times in total length.....4.
3A. Base of dorsal fin anterior to anus (fig. 54, C)....*Acanthophthalmus mariae.*
B. Base of dorsal fin above anus (fig. 54, D).....*Acanthophthalmus anguillaris.*
4A. Body with 5 oblique dark bands (fig. 54, E).
Acanthophthalmus sandakanensis.
B. Body with 10 or more dark bands.....5.
5A. Dorsal fin with black spot at bases of first rays....*Nemachilus selangoricus.*
B. Dorsal fin without spot at bases of first rays.....*Nemachilus olivaceus.*

Acanthopsis choirorhynchus (Bleeker). Figure 55.

Cobitis choirorhynchus Bleeker, 1854, Nat. Tijds. Ned. Indië, **7:** 95—Palembang, Sumatra.

Acanthopsis choirorhynchus Bleeker, 1863, Atlas Ichth., **3:** 9, pl. 102, fig. 1; Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3:** 25, fig. 8; Smith, 1945, Bull. U. S. Nat. Mus., no. 188, p. 296, fig. 60.

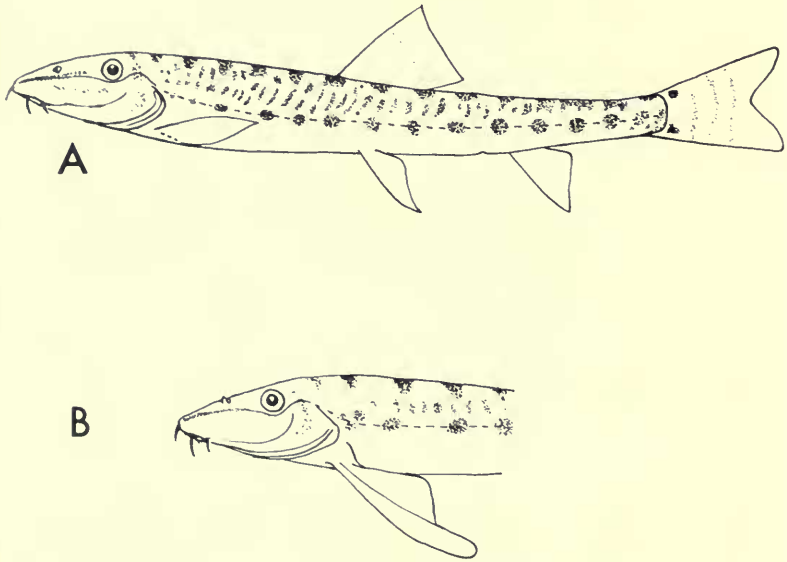

FIG. 55. *Acanthopsis choirorhynchus.* A, female; B, male.

Dorsal iii,8–9 (mean iii,8.6; N=10); ventral i,6 (N=10); pectoral i,7–9 (mean i,8; N=10); anal iii,6 (N=10); head 0.210–0.252 (median 0.240; N=13); snout 0.082–0.149 (median 0.133; N=12); eye 0.029–0.042 (median 0.037; N=12); interorbital 0.016–0.027 (median 0.021; N=12); depth 0.102–0.124 (median 0.109; N=12); width of body

in front of dorsal 0.062–0.086 (median 0.076; N=11); standard length 32.5–95.9 mm.; total length 39.0–112.4 mm.

Snout more than one-half length of head; bifid suborbital spine in front of eye, its base nearer to the anterior nostril than to the eye; the end of the spine when depressed does not reach front margin of eye; origin of dorsal situated in front of base of ventrals; scales minute but distinct, lateral line complete.

Males (32.5–48.8 mm.) have modified pectoral fins (fig. 55, B). At 32.5 mm. the first branched ray projects beyond the margin of the fin and each branch is subdivided at its tip so that the ray has 4 branches; in a fish 42.5 mm. the first branched ray is subdivided into 8 branches. The relative length of the first branched ray increases as the male increases in standard length: the first branched ray equals 0.175 of standard length in a 32 mm. fish, 0.186 in a 42 mm. fish, 0.215–0.229 in 48 mm. fishes, and 0.230 in a 50 mm. fish. The last two pectoral rays are approximately two-thirds the length of the immediately preceding ray. In mature females (up to 95.9 mm.) the margin of the pectoral fin is pointed; the second branched ray is the longest but it does not project beyond the margin of the fin, and the last two pectoral rays are only slightly shorter than the preceding one. The length of the second branched ray is equal to 0.131–0.141 of standard length in females.

The digestive tract is a short, straight tube, measuring 37 mm. in 72 mm. fish. Items identified in smears made from the stomach contents of four specimens are listed in Table 9.

TABLE 9.—Frequency of Material Found in Smears of Stomach Contents of *Acanthopsis choirorhynchus*

	Stomach 1	*Stomach 2*	*Stomach 3*	*Stomach 4*
Diatoms		present	present	present
Protozoans		1		2
Rotifers				1
Nematodes	many	many	many	many
Cladocerans	1	1		
Copepods			11	4
Ostracods				1
Diptera larvae	3	1	1	3
Plecoptera nymphs			1	
Acarina	2	1		
Plant fragments	present	present	present	present
Chitinous fragments	present		present	present
Sand grains	present	present	present	present

Color pale yellowish with short dark crossbars in the vertebral region and a row of round spots mid-laterally; narrow chevrons or narrow dark bars between mid-lateral and vertebral spots.

These fish live both in turbid, swamp forest streams with plant detritus on the muddy bottoms and in hill streams having clear water and sand, gravel, and rock bottoms. They are also found in shallow water on gravel bars in the middle of the Kinabatangan River.

Localities.—Kinabatangan District, Deramakot (64), Kinabatangan River below mouth of Sungei Malubok (23).

Acanthophthalmus mariae,[1] new species. Figure 56.

Holotype.—Chicago Natural History Museum no. 68161. A mature male, 51.6 mm. in standard length, from a small tributary of the Kinabatangan River at Deramakot, Kinabatangan District, North Borneo. Collected May 2, 1956, by R. F. Inger and P. K. Chin.

Paratypes.—CNHM 68162 (41), CNHM 68163 (57), and CNHM 68164 (14) from the type locality; CNHM 68165 (2) from a stream in the swamp forest at Deramakot.

Diagnosis.—An *Acanthophthalmus* with a comparatively elongate body (depth 0.08–0.12), with base of dorsal fin anterior to anus, with a nasal barbel, with lips not fringed, and body without vertical bands.

Description (data on holotype in parentheses).—Dorsal ii,5 in juveniles (below 40 mm.), i,6 in adults (i,6) (N=11); pectoral i,6–7 (i,7) (mean i,6.6; N=11); ventral i,4–5 (i,5) (mean i,4.5; N=11);

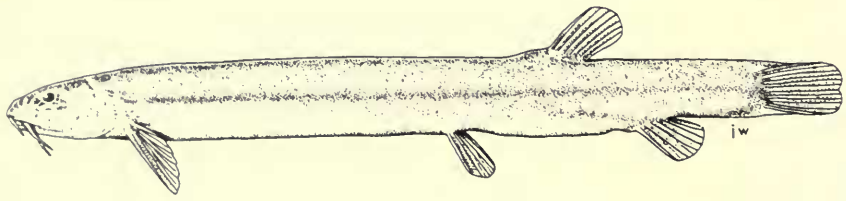

FIG. 56. *Acanthophthalmus mariae*, new species.

anal ii,5 (ii,5) (N=11); head 0.141–0.160 (0.147) (median 0.149; N=14); depth 0.082–0.116 (0.096) (median 0.094; N=14); snout 0.045–0.065 (0.054) (median 0.052; N=12); eye 0.012–0.019 (0.019)

[1] We are naming this species after our wives, both of whom are named Mary.

(median 0.013; N=11); interorbital 0.016–0.023 (0.023) (median 0.019; N=11); standard length 36.0–58.0 mm. (51.6); total length 40.9–65.8 mm. (57.2).

Body compressed, elongate, depth 8–12 in standard length, 10–14 in total length; dorsal and ventral profile parallel from rear of head to caudal; snout blunt; eye covered by skin, smaller than interorbital; a large bifid suborbital spine, much longer than eye; mouth inferior; lips thick, not papillose or fringed; a large pair of rostral barbels; a pair of maxillary and a pair of mandibular barbels; anterior nostril tubular, the posterior rim drawn out into a nasal barbel; gill opening narrow, ending at origin of pectoral.

Pectoral and ventral fins inserted low on sides; ventral and dorsal insertions in second half of body; entire base of dorsal fin anterior to anus; origin of anal in last fifth of body; caudal fin truncate or very feebly emarginate.

Body with minute scales; no lateral line.

Color in alcohol brownish above, lighter below; vertebral region and often upper half of sides with irregular light vermiculations; usually a dark mid-lateral streak; ventral surface immaculate yellowish brown; pectoral and ventrals colorless; dorsal and anal rays usually dusky, the dorsal darker than the anal; caudal rays brownish.

The second pectoral ray in mature males was about 3 times as thick as the succeeding rays. The pectoral fin was relatively longer in males, the fin being 0.091–0.109 in the four largest males (49.6–53.1 mm.) and 0.067–0.085 in the four largest females (53.0–58.0 mm.).

Habitat.—This species was collected in both clear and muddy forest streams.

Comparisons.—The absence of dark vertical bands distinguishes *mariae* from all species of the genus except *borneensis, javanicus, pahangensis, anguillaris,* and some specimens of *muraeniformis.* The presence of nasal barbels differentiates it from all of these non-banded species except *anguillaris.* The body depth of *anguillaris* is smaller than that of *mariae;* the total length is 13–18 times body depth in *anguillaris,* 10–14 in *mariae.* The entire base of the dorsal is anterior to the anus in *mariae* but not in *anguillaris.*

Locality.—Kinabatangan District, Deramakot (115).

Acanthophthalmus anguillaris Vaillant. Figure 57.

Acanthophthalmus anguillaris Vaillant, 1902, Notes Leyden Mus., 24: 151 Kapoeas, Borneo.

Acanthophthalmus vermicularis Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., 3: 34, 35; Hora, 1941, Bull. Raffles Mus., no. 17, p. 51.

Cobitophis anguillaris Smith, 1945, Bull. U. S. Nat. Mus., no. 188, p. 301.

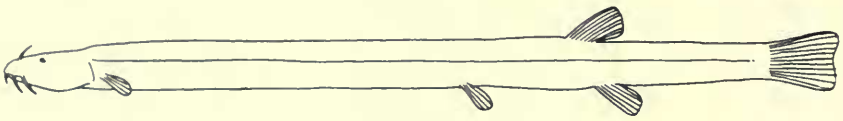

FIG. 57. *Acanthophthalmus anguillaris.*

Dorsal i,6; pectoral i,6; ventral i,4–5; anal ii,5; head 0.109–0.209; depth 0.062–0.088; eye 0.006–0.013; interorbital 0.017–0.032; snout 0.043–0.083; standard length 21.5–57.3 mm.; total length 24.3–62.8 mm.

Color in life pinkish brown, lighter below; no bands or spots; in alcohol, light grayish brown.

Smith (1945) gave reasons for synonymizing *vermicularis.* At our request Dr. Boeseman of the Leyden Museum has kindly re-examined the holotype of *anguillaris* and confirms the fact, reported by Smith, that Weber and de Beaufort were in error in their description of the positions of the dorsal and anal bases. According to Hora (1941), *vermicularis* has a pair of nasal barbels but *anguillaris* does not. Dr. Boeseman informs us that a nasal barbel, formed by the posterior rim of the nasal tube, is present in the holotype of *anguillaris.*

Our two specimens were collected in a small, muddy stream in lowland rain forest.

Locality.—Tawau District, Kalabakan, Sungei Marikut (2).

Acanthophthalmus sandakanensis new species. Figures 54, E, and 58.

Holotype.—Chicago Natural History Museum no. 68158. A mature male, 31.4 mm. in standard length, from the Sepilok Forest Reserve, Sandakan District, North Borneo. Collected April 9, 1956, by R. F. Inger.

Paratypes.—CNHM 68159 (24), from the type locality; CNHM 44800 (7) and CNHM 51795 (5), from pools six miles northwest of Sandakan; CNHM 44799 (2) from a stream 16 miles northwest of Sandakan.

Diagnosis.—An *Acanthophthalmus* with comparatively deep body (0.12–0.20), with base of dorsal in front of anus, with thickly fringed

posterior lip, and with 5 irregular oblique dark bars on body and one oblique stripe before eye.

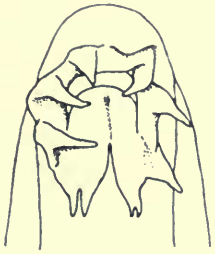

FIG. 58. Mouth of *Acanthophthalmus sandakanensis*.

Description (data on holotype in parentheses).—Dorsal i–ii,5–6 (ii,5) (mean of branched rays 5.8; N=12); pectoral i,5 (i,5) (N=12); ventral i–ii,4 (i,4) (N=12); anal i,5 (i,5) (N=12); head 0.156–0.267 (0.222) (median 0.222; N=18); depth 0.120–0.205 (0.152) (median 0.151; N=18); snout 0.059–0.078) (0.066) (median 0.070; N=7); eye 0.026–0.031 (0.028) (median 0.028; N=6); standard length 17.3–37.4 mm. (31.4); total length 21.0–44.1 mm. (38.2).

Body compressed, moderately elongate, depth 5 to 8 times in standard length; dorsal and ventral profiles subparallel from eye to caudal; head 4 to 6 times in standard length; snout blunt; eye covered by skin, subequal to interorbital width; a bifid suborbital spine under eye, length of spine about equal to eye; mouth (fig. 58) inferior; lips thick, dotted with tiny papillae; three pairs of barbels, rostral, maxillary and mandibular, attached to lips; barbels subequal; lower lip with leaf-like lobes on each side of symphysis, each lobe tipped with one or more barbel-like projections; anterior nostril tubular, about two-thirds diameter of eye; nasal barbel absent; gill opening short, straight, above base of pectoral.

Pectoral and ventral fins inserted low on sides, subequal and about two-thirds of head length; ventral insertion closer to snout than to caudal; origin of dorsal much behind ventral insertion; end of base of dorsal slightly in front of anus.

Body with minute scales; lateral line absent; head scaleless.

In alcohol ground color light yellowish brown; a dark oblique streak from eye to tip of snout; a similar streak from eye to lower posterior corner of opercle; a dark brown spot below suborbital spine; a pair of dark spots or a dark arch at beginning of interorbital; a

narrow band or pair of dark spots across nape; five irregular, oblique, dark brown bands on sides of body, usually interrupted on back; three bands before dorsal; one through that fin and one on caudal peduncle; first four bands connected by dark bars or spots in mid-lateral region; small brown spots scattered over sides; ventral surfaces immaculate; dorsal fin with oblique brown band near base continuous with fourth body band; one or two narrower dark streaks across dorsal near margin; caudal vermiculated with brown; other fins hyaline.

Adult males (31–37 mm.) had the first two pectoral and the first ventral rays much thickened. The second pectoral ray, branched in females and juveniles, appeared unbranched in mature males. Strictly speaking, the holotype and the largest paratypic male had the pectoral formulas ii,4, though we have given it above as i,5 in order to avoid giving the impression that these two fishes had a different number of pectoral rays. These two males had low, spinose tubercles scattered over the dorsal surface of the head and the dorsal and lateral surfaces of the body.

Enlarged ova were present in two females 28.7 and 35.4 mm. long.

Habitat.—This species was collected in muddy pools and streams having maximum depths of about 1.5 meters.

Comparisons.—The ratio of total length to depth immediately sets off *sandakanensis* (less than 10) from the vermiform species (10 or more) of *Acanthophthalmus* (=*Cobitophis* Myers), which are not banded. The uniform body coloration of *A. borneensis* Boulenger, *javanicus* Bleeker, *pahangensis* de Beaufort, and *pangia* Hamilton, and the multi-banded patterns of *A. kuhli* Valenciennes, *myersi* Harry, *semicinctus* Fraser-Brunner, and *shelfordi* Popta distinguish them from *sandakanensis.*

The species most similar to *sandakanensis* is *lorentzi* Weber and de Beaufort (type locality Kapuas River, Borneo). Differences between these two species involve the number of crossbands on the body, the pattern on the head, the thickness of the lips, and the number of pectoral rays. Weber and de Beaufort (1916) figured three crossbands posterior to the dorsal in *lorentzi; sandakanensis* has only two. *Acanthophthalmus lorentzi* has six (according to the original description) or seven (according to the figure of Weber and de Beaufort, 1916) crossbands on the body, *sandakanensis* only four or five. The oblique stripe before the eye of the latter is not present in *lorentzi.* The description of *lorentzi* notes "lips rather thin." It

is impossible to refer to the lips of the present species as thin. *Acanthophthalmus lorentzi* has a pectoral count of i,8, *sandakanensis* i,5.

Localities.—Sandakan District, Sepilok Forest Reserve (25), Mile 6 (12) and Mile 16 (2) on Labuk Road, Sandakan.

The following key will assist in identifying the banded species of *Acanthophthalmus.*

1A. A broad dark band (several times diameter of eye) across nape.....2.
B. No or only a thin band (no wider than eye) across nape.....6.
2A. Dark markings in two rows, the lower not reaching mid-dorsum. *shelfordi* Popta.
B. Dark bands in one row, all crossing back.....3.
3A. Bands ending near mid-lateral line, dorsal ii,6..*semicinctus* Fraser-Brunner.
B. Bands extending far down sides; dorsal ii,7–8.....4.
4A. Bands lighter in center than at edges, or distinctly paired about a light vertical stripe.....5.
B. Bands neither paler in center nor paired.....*myersi* Harry.
5A. Body with about 17 bands, each divided by a light, vertical line. *kuhli* Valenciennes.
B. About 12 bands, each paler in center.....*sumatranus* Fraser-Brunner.
6A. Six or seven bands on body; pectoral i,8....*lorentzi* Weber and de Beaufort.
B. Four or five bands on body; pectoral i,5.....*sandakanensis*, new sp.

Nemachilus selangoricus Duncker. Figure 59.

Nemachilus selangoricus Duncker, 1904, Mitt. Nat. Mus. Hamburg, **21**: 175; Herre and Myers, 1937, Bull. Raffles Mus., no. 13, p. 65; Hora, 1941, Bull. Raffles Mus., no. 17, p. 57, figs. 2, 3.

Dorsal ii,9 (N=12); pectoral i,11–13 (mean i,12; N=9); ventral i,6,i (N=9); anal ii,5 (N=9); head 0.209–0.260 (median 0.237; N=9);

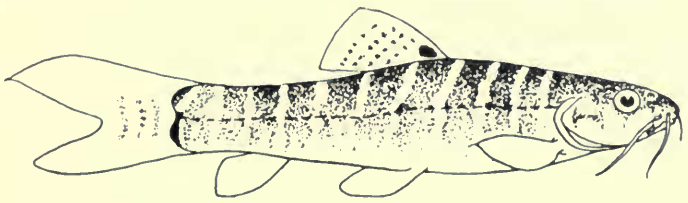

FIG. 59. *Nemachilus selangoricus.*

depth 0.152–0.183 (median 0.165; N=8); snout 0.063–0.092 (median 0.081; N=9); eye 0.044–0.058 (median 0.053; N=9); interorbital 0.056–0.069 (median 0.063; N=9); standard length 23.0–59.2 mm.; total length 29.7–78.0 mm.

Tips of ventrals reaching anus or beyond; caudal deeply forked, lobes pointed, dorsal lobe longer than ventral lobe.

Certain scales in the two rows flanking the lateral line bear small spines (fig. 60). These spines, four to nine in number in each row,

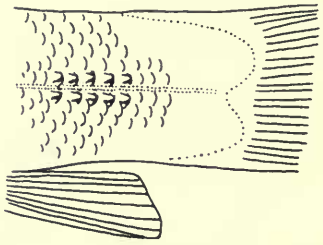

FIG. 60. Specialized peduncular scales of *Nemachilus selangoricus*.

are limited to the area above the base of the anal fin or slightly behind it.

Color in alcohol pale yellowish with about 15 broad brown bands narrowly separated and encircling body except for ventral region; in adults each dark band in at least the anterior half of the body partially divided by a light vertical streak; dorsal fin with a large black spot at bases of first three rays; two or three dark stripes across dorsal formed by small spots on the rays; three or four similar dark stripes on caudal fin.

Juveniles (less than 25 mm.) were encircled by very narrow dark bands separated by a space equal to the width of a band. The body pattern was thus very similar to that of *N. olivaceus*, but the characteristic black spot at the base of the dorsal was present even in these small specimens of *selangoricus*.

Mature males (46–50 mm.) had a fleshy preorbital hook similar in shape and position to that described for *olivaceus*. The dorsal surface of the first branched pectoral ray and a narrow strip of the membrane behind it bore small spinose tubercles in males. Three females (53.0–59.2 mm.) contained enlarged ova.

The stomachs of three specimens contained immature aquatic stages of Plecoptera, Trichoptera, and Chironomidae. One of these also contained an adult Hemiptera, probably of the family Cicadellidae.

All specimens were collected in a small clear stream over a sandy and gravelly bottom.

Localities.—Tawau District, Sungei Balung (Herre, 1940b), Kalabakan, Sungei Tawan (14).

Nemachilus olivaceus Boulenger. Figure 61.

Nemachilus olivaceus Boulenger, 1894, Ann. Mag. Nat. Hist., (6), **13**: 250—Bongon, North Borneo; Weber and de Beaufort, 1916, Fishes Indo-Austr. Arch., **3**: 41.

Dorsal ii,7–10 (mean ii,8.1; N=31); pectoral i,10–12 (mean i,11.3; N=33); ventral i,5–6,i (mean i,5.9,i; N=30); anal ii,5–6 (only one

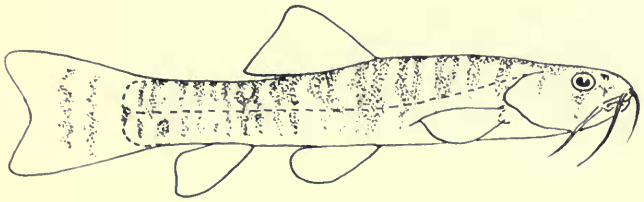

FIG. 61. *Nemachilus olivaceus.*

of 30 had ii,6); lateral line pores 88–104 (mean 94.4; N=10); head 0.212–0.256 (median 0.238; N=22); depth 0.133–0.194 (median 0.167; N=22); snout 0.065–0.090 (median 0.077; N=10); eye 0.036–0.067 (median 0.048; N=10); interorbital 0.053–0.071 (median 0.062; N=10); standard length 20.0–57.8 mm.; total length 25.9–73.0 mm.

Color in alcohol pale yellowish with 10–18 dark crossbands encircling body except for ventral region, which is unmarked; dorsal and caudal fins with two or three dark bands formed by small dark spots on the rays.

The dorsal surface of the first two pectoral rays in mature males (over 37 mm.) bore small spinose tubercles. These tubercles sometimes occupied a narrow strip of the membrane immediately behind the first branched pectoral ray. The males also had a fleshy preorbital hook extending just below the anterior corner of the eye. It is this hook, a feature of mature males in at least three species (*olivaceus, selangoricus,* and *fasciatus*), that Weber and de Beaufort (1916, p. 41) misinterpreted in reading Perugia's description of the species *papillosa.*

This species differs from the much more widely distributed *fasciatus* in the shape of the caudal fin, which is feebly emarginate and with rounded lobes in *olivaceus* but deeply emarginate and with

pointed lobes in *fasciatus*. The tips of the ventral fins reach at least as far as the anus in *olivaceus* but fail to reach the anus in *fasciatus*. These two species also differ in the shape of the patch of spinose tubercles on the pectoral fins in males. In *olivaceus* this patch is narrow and elongate and does not occupy more than half the width of the membrane between the first two branched pectoral rays. In *fasciatus* this patch is much wider, occupying the entire width of the membrane between the two rays.

Each of five stomachs contained immature aquatic insects (Plecoptera, Trichoptera, and Chironomidae). One stomach contained five copepods.

This species lives in a variety of situations: 33 specimens were collected in small muddy streams having silty bottoms; 77 were caught in small clear streams having sandy or gravelly bottoms; 56 were caught over a gravel bar in the center of the turbid Kinabatangan River.

Localities.—Kinabatangan District, Deramakot (151), small stream one mile above Sungei Tabalin Besar (1), Tambisan Island (1); Kudat District, Bongon (Boulenger, 1894); Lahad Datu District, Sungei Edam (1); Ranau District, Brakakis (1); Sandakan District, tributary of Sungei Sapagaya (4); Tawau District, Kalabakan, Sungei Tawan (9).

SILUROIDEA

Key to Families of Catfishes Known from North Borneo

1A. Dorsal fin, if present, spineless ..... 2.
B. Dorsal always present, with strong spine ..... 3.
2A. Dorsal with seven or fewer rays, sometimes absent ..... *Siluridae* (p. 128).
B. Dorsal present, long (more than 30 rays) ..... *Clariidae* (p. 130).
3A. No adipose or rayless fin; caudal extending forward as second dorsal (fig. 62, A); anal fused to caudal ..... *Plotosidae.*[1]
B. Adipose fin present (fig. 62, B); caudal not extending forward ..... 4.
4A. Nasal barbel present (fig. 62, C) ..... 5.
B. Nasal barbel absent ..... 7.
5A. Body with longitudinal rows of tubercles (fig. 62, D) ..... *Akysidae* (p. 133).
B. Body without such tubercles ..... 6.
6A. Anterior nostril widely separated from posterior (fig. 62, E) . *Bagridae* (p. 135).

[1] This family has not yet been reported from the fresh waters of North Borneo, although it may occur in the larger rivers and is known from brackish or marine situations in eastern North Borneo.

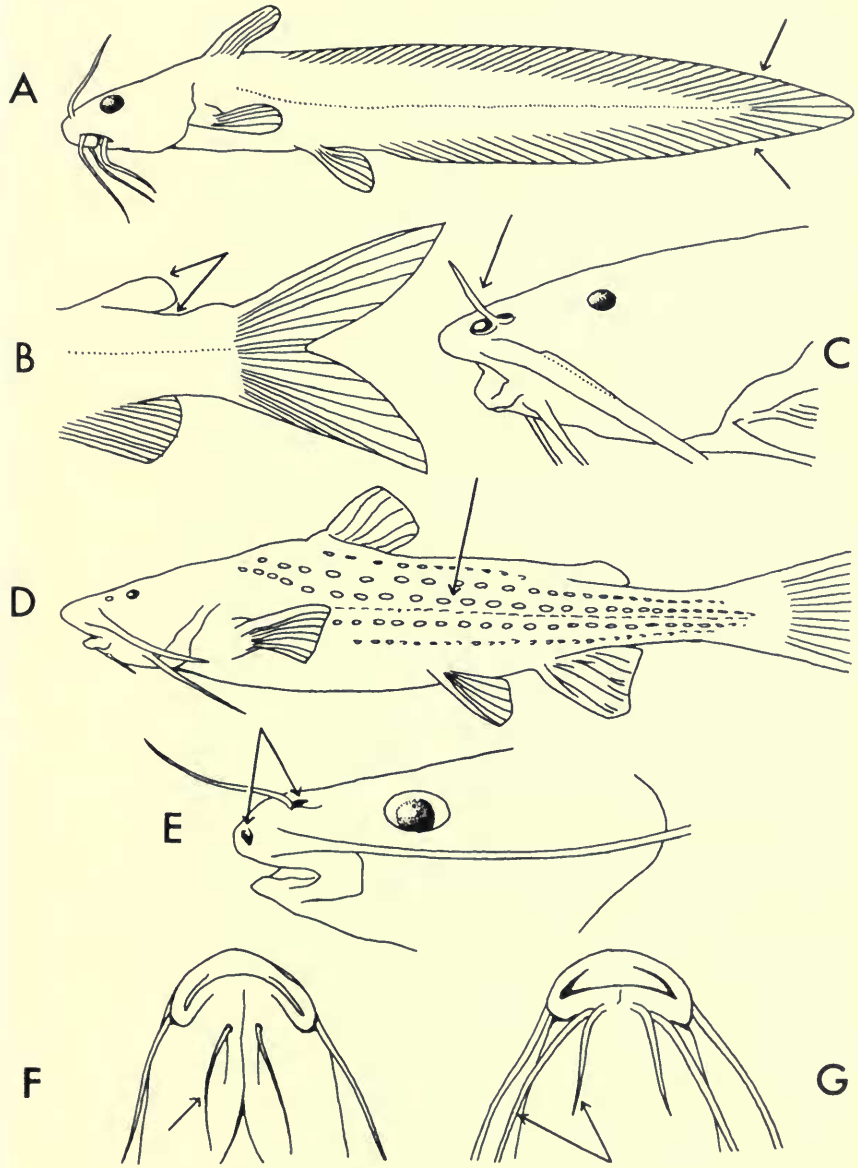

FIG. 62. Key to families of Siluroidea.

B. Anterior and posterior nostrils close together, separated by nasal barbel (fig. 62, C) ..... *Sisoridae* (p. 145).

7A. One pair of barbels under head (fig. 62, F); anal fin with 28 or more rays. *Schilbeidae* (p. 146).

B. Two pairs of barbels under head (fig. 62, G), or none; anal fin with less than 28 rays ..... *Ariidae* (p. 149).

SILURIDAE

KEY TO SPECIES KNOWN FROM NORTH BORNEO

1A. Side with row of large black spots; eye entirely above horizontal from corner of mouth (fig. 63, A) ..... *Wallago maculatus.*

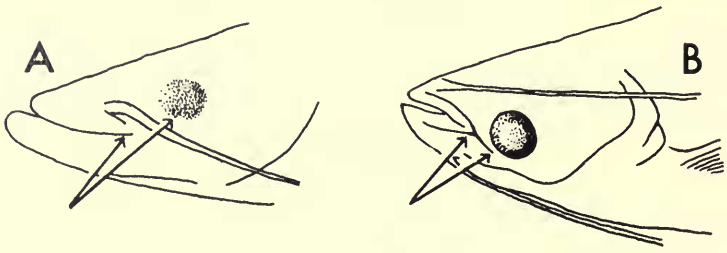

FIG. 63. Key to species of Siluridae.

B. Side without black markings; horizontal from corner of mouth passing through eye (fig. 63, B) ..... 2.

2A. Dorsal fin with four rays; mandibular barbels reaching mid-length or posterior third of anal fin ..... *Ompok sabanus.*

B. Dorsal absent; mandibular barbels very short ..... *Kryptopterus parvanalis.*

Wallago maculatus Inger and Chin

Wallago maculatus Inger and Chin, 1959, Fieldiana: Zool., **39**: 279—Deramakot, Kinabatangan District, North Borneo.

Dorsal i,4 (N=11); pectoral I,13–15 (mean I,14.1; N=12); ventral i,7–9 (mean i,8.6; N=13); anal ii–iv,56–64, total rays 60–66 (mean total 63.2; N=13); gill rakers 3–5+10–14, total 13–19 (mean total 16.1; N=14); branchiostegals 13–15 (mean 13.6; N=14); head 0.249–0.267 (median 0.256; N=12); depth 0.169–0.222 (median 0.193; N=10); standard length 86.8–750.0 mm.

The largest specimen weighed 10.5 pounds.

Color (shortly after death) olive above, silvery below, with a row of bold dark blotches below lateral line. In alcohol slate above, lighter below, with blotches conspicuous; fins with a very light dust-

ing of melanophores on membrane; dorsal membrane darker; a small black spot at base of caudal.

Specimens were collected in the Kinabatangan River as well as in small forest tributaries. No preference for either clear or turbid water was shown by our sample, half of which was obtained in clear water and half in turbid.

Food remains were found in only three stomachs; one contained insect fragments, one a prawn, and one a small flower.

This species is one of the best-flavored fishes in the Kinabatangan basin. It is caught with cast net, hook-and-line, or traps.

Local name.—"Tapah" or "Tapoh" (Malay and Orang Sungei).

Localities.—Kinabatangan District, Deramakot (12), Lamag (3).

Ompok sabanus Inger and Chin

Ompok sabanus Inger and Chin, 1959, Fieldiana: Zool., **39**: 282—Segama River, Lahad Datu District, North Borneo.

Dorsal 4; pectoral I,11–13 (mean I,12.5; N=13); ventral i,5–6 (only 3 out of 27 had 5 branched rays); anal ii,53–64 (mean ii,58.3; N=44); gill rakers 3–4+10–17, total 13–21 (mean total 17.1; N=29); branchiostegals 9–12 (mean 10.5; N=32); head 0.174–0.236 (median 0.193; N=24); depth 0.211–0.255 (median 0.239; N=20); standard length 68.8–149.0 mm.; total length 84–178 mm.

Color in alcohol pale brown, darker along back; a dark humeral spot; a thin mid-lateral black line, ending at caudal base in a diffuse round dark spot; fins colorless.

Two females (129–134 mm.) contained enlarged eggs. Males over 100 mm. had 8–14 (mean 10.9; N=16) retrorse hooks on the inside of the pectoral spine.

At Deramakot fishermen using cast nets in the Kinabatangan River caught more of this fish than any other. Of our specimens, 46 were caught in the Kinabatangan River, 21 in the mouths of small muddy tributaries, and 2 farther upstream in a small turbid creek. None were obtained in clear water.

Three of the five food-containing stomachs examined had aquatic insects (nymphs of Plecoptera and larvae of midges and Trichoptera); one, fragments of terrestrial insects; and two, insect fragments that could not be identified as aquatic or terrestrial with certainty. Specimens caught with cast nets were attracted to the site by mammalian viscera and blood dumped into the river by us.

Local name.—"Lais" (Malay and Dusun).

Localities.—Kinabatangan District, Bukit Besar (4), Danau Bilit (6), Deramakot (47), Danau Duadan (3), Lamag (5), Malapi (11), Pintasan (4), 10 miles upstream from Pintasan (19); Lahad Datu District, Segama River at Segama Estate (12); Tawau District, Kalabakan, Sungei Tawan (1).

Kryptopterus parvanalis Inger and Chin

Kryptopterus parvanalis Inger and Chin, 1959, Fieldiana: Zool., **39**: 284, fig. 46—Deramakot, Kinabatangan District, North Borneo.

Pectoral I,13–15 (mean I,13.9; N=19); ventral i,6–8 (mean i,7.2; N=8); anal 71–83 (mean 76.1; N=22); gill rakers 4–7+17–21, total 22–27 (mean total 24.3; N=20); branchiostegals 13–16 (mean 14.1; N=18); head 0.203–0.238 (median 0.216; N=18); depth 0.199–0.238 (median 0.216; N=16); standard length 57.2–244.0 mm.; total length 68–282 mm.

Color in alcohol pale brown, much darker along mid-dorsal area; a dark humeral spot; fins colorless.

All of our specimens were collected in large, turbid rivers or their cut-off meanders.

Local names.—"Lais" (Malay), "Limpatah" (Orang Sungei).

Localities.—Kinabatangan District, Deramakot (17), Danau Bilit (5), Danau Bukit Garam (2), Lamag (1); Labuk and Sugut District, Labuk River (1); Lahad Datu District, Segama River at Segama Estate (3).

CLARIIDAE

Key to Species Known from North Borneo

1A. Dorsal and anal fins not united with caudal (fig. 64, A); distance from occipital process to dorsal 2.0–2.5 times in head measured to end of occipital process. *Clarias teysmanni.*

B. Dorsal and anal united with caudal (fig. 64, B)..... 2.

2A. Dorsal rays 80 or more; anal rays 65 or more; a caudal projection from center of vomerine tooth band (fig. 64, C)..... *Prophagorus nieuhofi.*

B. Dorsal rays 70 or less; anal rays 60 or less; no caudal projection from vomerine tooth band (fig. 64, D)..... *Prophagorus cataractus.*

All the above species of clariids are called "Keli" (Malay and Dusun).

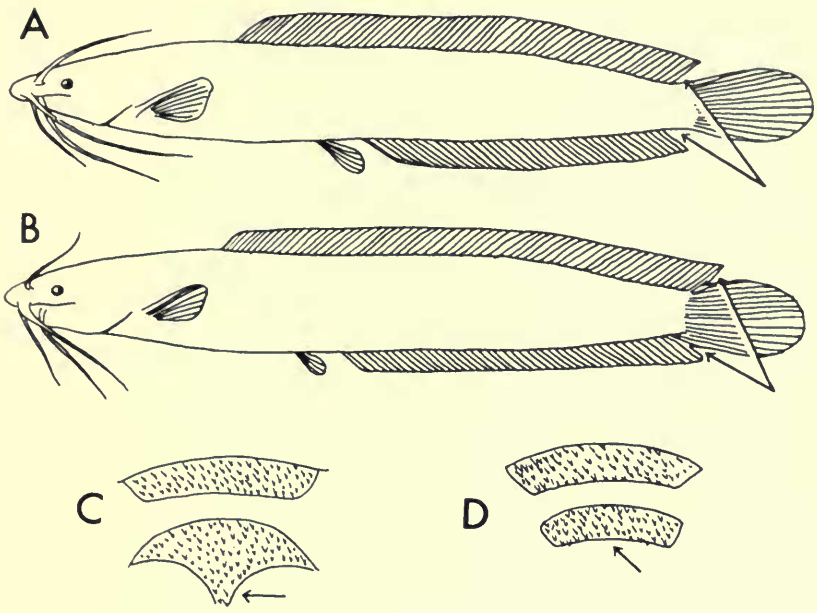

FIG. 64. Key to species of Clariidae.

Clarias teysmanni Bleeker. Figure 65.

Clarias teysmanni Bleeker, 1857, Nat. Tijds. Ned. Indië, **13**: 344—Tjikoppo, Java; Weber and de Beaufort, 1913, Fishes Indo-Austr. Arch., **2**: 191; Herre, 1933, Jour. Pan-Pacific Res. Inst., 8, no. 4, p. 3; Inger, 1955, Fieldiana: Zool., **37**: 65.

Dorsal 65–79 (mean 71.9; N=39); pectoral I,7–10 (mean I,8.7; N=23); ventral i,5; anal 51–66 (mean 58.4; N=39); gill rakers 3–5+12–16, total 17–20 (mean total 18.3; N=19); head 0.176–0.213 (me-

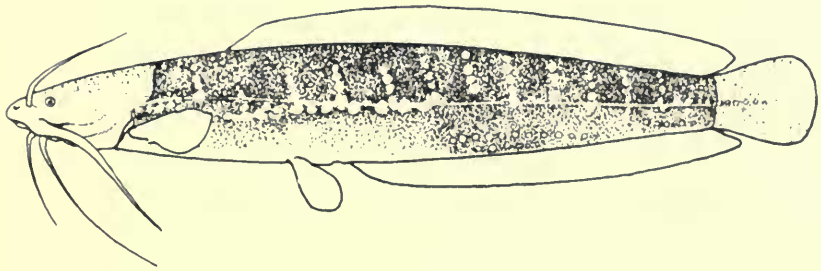

FIG. 65. *Clarias teysmanni*.

dian 0.196; N=10); head measured to end of occipital process 0.217–0.271 (median 0.239; N=48); distance from occipital process to dorsal 1.80–2.58 (median 2.28; N=40) in head measured to end of occipital process; depth 0.134–0.177 (median 0.150; N=22); standard length 93.0–252 mm.; total length 108–282 mm.

Color slate brown above and on sides, whitish below; small white spots arranged in vertical rows above mid-lateral line; spots arranged in longitudinal rows below mid-lateral line; fins colored as adjacent parts of body.

Three females (122.5–173.5 mm.) contained enlarged ova.

Clarias teysmanni occurs from close to the tidal zone to the headwaters of streams in eastern North Borneo. It is probably more abundant in clear than in muddy water as only 15 per cent of those for which data are available were taken in turbid water.

The food consists primarily of aquatic insects and crustaceans, which appeared in 10 of 13 stomachs examined. Terrestrial insects were found in 5, a tadpole of the frog *Megophrys hasselti* in one, and leaf fragments in 3.

Localities.—Jesselton District, Jesselton (2); Keningau District, Sungei Membikit (5); Kinabatangan District, Deramakot (8), Sungei Gaja (3), tributary of Sungei Kretam Kechil (5); Labuk and Sugut District, Labuk River (2); Sandakan District, Sungei Kabili (3), Sandakan (9), Sandala Estate (5), tributary of Sungei Sapagaya (2), Sungei Sepilok (7), Sungei Sibuga (1); Tawau District, Kalabakan, Sungei Tawan (4), Sungei Balung (1), Sungei Kinabutan (8).

Prophagorus nieuhofi (Valenciennes). Figure 66.

Clarias nieuhofi Valenciennes *in* Cuvier and Valenciennes, 1840, Hist. Nat. Poissons, **15**: 386—no locality given; Weber and de Beaufort, 1913, Fishes Indo-Austr. Arch., **2**: 189; Fowler, 1941, Bull. U. S. Nat. Mus., no. 100, **13**: 735.

Prophagorus nieuhofi Smith, 1939, Copeia, **1939**: 236.

Dorsal 83–85; pectoral I,8–9; ventral i,5; anal 74–75; branchiostegals 10; head 0.149–0.164; depth 0.123–0.133; head measured to end of occipital process 0.185–0.194; distance from occipital process to dorsal 1.92–2.26 in head measured to end of occipital process; standard length 170–231 mm.; total length 194–261 mm.

Color in alcohol slate; no light spots on body; fins colored like body.

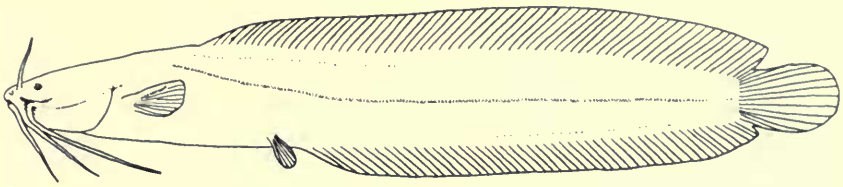

FIG. 66. *Prophagorus nieuhofi.*

The dorsal counts and the ratios of head length are smaller than those given by Weber and de Beaufort. The differences are not sufficiently large to warrant recognition of a distinct taxonomic entity.

Localities.—Jesselton District, 2 miles south of Jesselton (1); Labuk and Sugut District, Labuk River (2); Sandakan District, Sandala Estate (1); Tuaran District, Tuaran (1).

Prophagorus cataractus (Fowler)

Phagorus cataractus Fowler, 1939, Proc. Acad. Nat. Sci. Philadelphia, **91**: 54, figs. 1–3—Trang, Thailand.

Prophagorus cataractus Smith, 1945, Bull. U. S. Nat. Mus., no. 188, p. 353.

Dorsal 57; pectoral I,9; ventral i,5; anal 56; head 0.196; snout 0.067; eye 0.015; head measured to end of occipital process 0.243; distance from occipital process to dorsal 2.03 in head measured to end of occipital process; standard length 130 mm.; total length 145.5 mm.

Nasal barbel reaching to end of occipital process; maxillary barbel to dorsal origin; mandibular barbel to tip of pectoral; mental barbel to mid-length of pectoral.

The coloration is similar to that of *Clarias teysmanni.*

This fish differs from the type of *cataractus* in having a smaller dorsal count (57 as opposed to 67). However, a range of 10 for dorsal counts is not uncommon in clariids. The close agreement in other characters supports this identification.

Locality.—Sandakan District, Melantak, west of Sandakan (1).

AKYSIDAE

Only two species are known from North Borneo. *Acrochordonichthys pachyderma* is a uniform brown color without dark blotches and has no teeth on the pectoral spine. *Acrochordonichthys melanogaster,* on the other hand, is either blackish brown in color or is distinctly

marked with lighter and darker areas. Its pectoral spine has teeth on the rear margin.

Acrochordonichthys pachyderma Vaillant. Figure 62, D.

Acrochordonichthys pachyderma Vaillant, 1902, Notes Leyden Mus., **24**: 66, figs. 11–13—Bluu River, Indonesian Borneo.

Dorsal I,5; pectoral I,7; ventral i,5; anal iii,6; caudal i,11,ii; gill rakers 1+4; head 0.289; depth 0.230; standard length 85.8 mm.; total length 102 mm.

Maxillary barbel reaching almost to end of opercle, outer mandibular barbel to pectoral insertion.

Color in alcohol uniform clay-color; all fins except adipose with rows of small black spots.

This specimen contained enlarged ova.

This species was distinguished from *melanogaster* by Vaillant on the basis of its uniformly light coloration and the absence of barbs on the rear edge of the pectoral spine. The present specimen agrees with *pachyderma* in these characters and further differs from those identified as *melanogaster* in the dorsal extension of the gill opening, which extends slightly above the level of the pectoral spine in the latter but does not reach so high in *pachyderma*. The adpressed dorsal fails to reach the beginning of the adipose crest in *pachyderma* whereas it overlaps the adipose crest in *melanogaster*.

Caught on hook-and-line with earthworm bait in the muddy Kinabatangan River at flood stage.

Locality.—Kinabatangan District, Deramakot (1).

Acrochordonichthys melanogaster (Bleeker). Figure 67.

Pimelodus melanogaster Bleeker, 1854, Nat. Tijds. Ned. Indië, **7**: 89—Palembang, Sumatra.

Acrochordonichthys melanogaster Bleeker, 1858, Ichth. Arch. Ind. Prodr., I Siluri, p. 224; Weber and de Beaufort, 1913, Fishes Indo-Austr. Arch., **2**: 369.

Dorsal I,5; pectoral I,7; ventral i,5 (one with ii,4 on one side); anal ii–iii,5–6, total rays 8–9 (mean branched rays 5.6; N=7); caudal i,11,ii; gill rakers 1+5; head 0.253–0.289; depth 0.185–0.207; standard length 33.9–80.4 mm.; total length 42–95 mm.

Maxillary barbel reaching to end of opercle or to insertion of pectoral; outer mandibular barbel reaching to just beyond pectoral insertion.

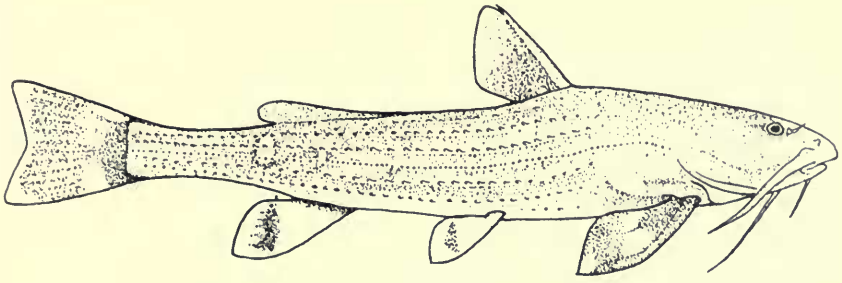

FIG. 67. *Acrochordonichthys melanogaster.*

Color in alcohol light brown with irregular dark brown blotches; smaller specimens (up to 42 mm.) darker than the larger; all fins usually with broad black bands; dorsal solid black except for yellow margin.

We follow Weber and de Beaufort (1913) in considering *A. obscurus* Popta, *A. büttikoferi* Popta, *A. varius* Popta, and *Sosia chamaeleon* Vaillant synonyms of *melanogaster*.

The largest fish is an adult female containing ripe ova.

The small specimens were seined in shallow water on a gravel bar in the Kinabatangan River. The adult was caught on hook-and-line with earthworm bait while the river was in flood.

Localities.—Kinabatangan District, Kinabatangan River at Deramakot (1), below mouth of Sungei Malubok (9).

BAGRIDAE

KEY TO SPECIES KNOWN FROM NORTH BORNEO

1A. Free orbital margin (fig. 68, A) (*Mystus*) ..... 2.
B. Eye covered by skin (fig. 68, B) (*Leiocassis*) ..... 5.
2A. Adipose fin very long; anal base usually more than 2.5 times in adipose base (fig. 68, C) ..... *Mystus sabanus.*
B. Adipose fin shorter; anal base less than 2.5 times in adipose base (fig. 68, D) .. 3.
3A. A thin dark line running length of body on side (fig. 68, E). *Mystus nemurus.*
B. No dark line on side ..... 4.
4A. Dorsal fin when laid back against body reaching adipose fin (fig. 68, F). *Mystus baramensis.*
B. Dorsal fin not reaching adipose (fig. 68, G) ..... *Mystus planiceps.*
5A. Maxillary barbel reaching pectoral fin (fig. 68, H); no contrasting light and dark bands or spots on sides ..... *Leiocassis robustus.*
B. Maxillary barbel not reaching pectoral; sides with contrasting light and dark bands ..... 6.

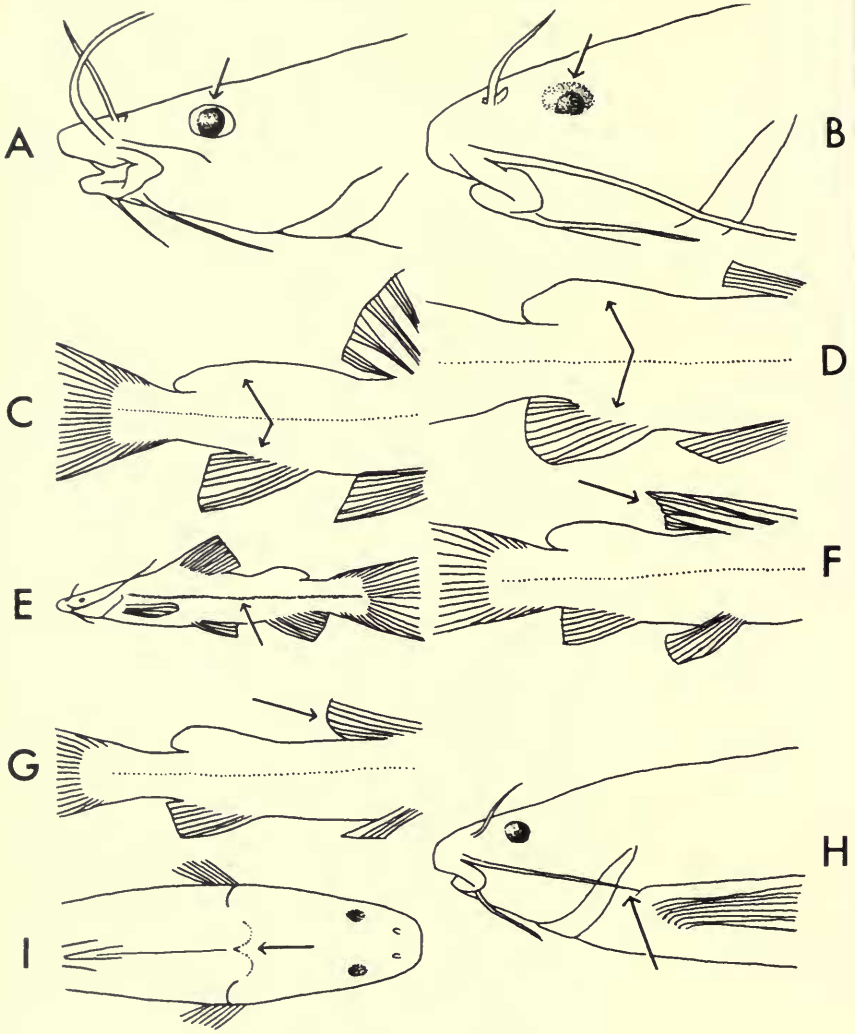

FIG. 68. Key to species of Bagridae.

6A. Adipose fin equal to or shorter than its distance from dorsal. *Leiocassis poecilopterus*.

B. Adipose fin distinctly longer than its distance from dorsal.....7.

7A. Occipital process slightly longer than its basal width (fig. 68, I); about as long as eye diameter.....*Leiocassis micropogon*.

B. Occipital process several times longer than its basal width; much longer than eye diameter.....*Leiocassis merabensis*.

Mystus Scopoli

Species of this genus are important food fishes for the people living along large rivers. The flesh is firm and has an excellent flavor. All species are called "Baung" (Malay and Orang Sungei) and "Sobong" (Dusun of Kota Belud).

Mystus sabanus Inger and Chin

Mystus sabanus Inger and Chin, 1959, Fieldiana: Zool., **39**: 294—Deramakot, Kinabatangan District, North Borneo.

Dorsal II,7; pectoral I,9–10 (only one I,9; N=10); ventral i,5; anal iv–v,8–9 (mean of branched rays 8.4; N=10); gill rakers 5–6+ 14–16, total 19–22 (mean total 20.5; N=10); branchiostegals 9–13 (mean 10.7; N=10); head 0.259–0.310 (median 0.276; N=9); depth 0.170–0.235 (median 0.201; N=8); eye 0.041–0.058 (median 0.046; N=10); adipose base 0.307–0.357 (median 0.320; N=19); anal in adipose 2.45–3.58 (mean 2.90; N=11); standard length 40.1–152.0 mm.; total length 60–214 mm.

Nasal barbel extending beyond eye, usually reaching end of preopercle; maxillary barbel usually reaching caudal base.

The extremely long adipose fin, which begins almost immediately behind the dorsal and is about one-third the standard length, distinguishes *sabanus* from all other species of *Mystus* now known from North Borneo.

Color in alcohol pale yellowish brown, light below; a dark humeral spot; membranes of dorsal, anal, and caudal dusky; other fins colorless.

All known specimens of *sabanus* have been caught in the Segama and Kinabatangan Rivers, but not in any of their tributaries. Apparently it is confined to large rivers and in this restriction differs from other Bornean species of *Mystus*. Four were collected with a cast net along the bank, four by hook-and-line, and eight with a seine, all in the Kinabatangan.

Six stomachs containing food held insect remains and, in two instances, spiders. Aquatic insects, such as nymphs of Ephemeroptera and neuropteran and psephinid beetle larvae, were found in four. Dipteran larvae, which may be aquatic, occurred in three stomachs. Distinctly terrestrial arthropods, such as ants and a nasute termite, appeared in only one stomach. The spiders may have been aquatic or riparian.

Localities.—Kinabatangan District, Kinabatangan River at Deramakot (8), below mouth of Sungei Malubok (8); Lahad Datu District, Segama River at Segama Estate (1).

Mystus nemurus (Valenciennes). Figure 69.

Bagrus nemurus Valenciennes *in* Cuvier and Valenciennes, 1839, Hist. Nat. Poissons, **14:** 423—Java.

Mystus nemurus Herre and Myers, 1937, Bull. Raffles Mus., no. 13, p. 69; Inger, 1955, Fieldiana: Zool., **37:** 65.

Macrones nemurus Weber and de Beaufort, 1913, Fishes Indo-Austr. Arch., **2:** 341; Hardenberg, 1936, Treubia, **15:** 234.

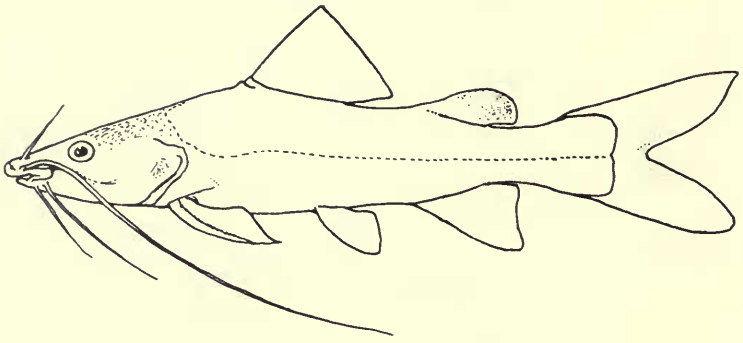

FIG. 69. *Mystus nemurus.*

Dorsal II,7; pectoral I,7–9 (mean I,8.0; N=34); ventral i, 5; anal iv–vi,7–8 (mean of branched rays 8.2; N=36); gill rakers 3–5+9–16, total 13–20 (mean total 15.7; N=21); branchiostegals 10–12 (mean 10.7; N=20); head 0.296–0.325 (median 0.313; N=19); depth 0.186–0.248 (median 0.211; N=19); eye 0.037–0.062, varying with standard length; anal in adipose 0.92–1.72 (median 1.20; N=29); adipose in dorsal-adipose distance 0.54–1.27 (median 0.84; N=20); standard length 50.4–570 mm.; total length 65–720 mm.

Color in alcohol dark slate brown above, lighter in lower half; a thin black longitudinal line in center of side, sometimes obscure in anterior third of body; fins colored like adjacent part of body.

The thin dark line along the side distinguishes *nemurus* from all other species of *Mystus* now known from Borneo.

Enlarged ova were found in 5 females measuring 123–210 mm.

Mystus nemurus occurs from tidal zone at the mouths of rivers, where it may actually live in brackish water (Inger, 1955), to the

headwaters of most basins. Moderate-sized individuals (ca. 150 mm.) will live in tributaries having pools only 40 cm. (ca. 16 inches) deep. No distinct preference for either clear or muddy water is evident in our experience.

A wide variety of food is eaten. Of 43 stomachs containing food, 13 held crabs; 2, prawns; 10, fragments of crustaceans (probably mostly crabs); 9, terrestrial insects; 4, aquatic insects; 5, unidentifiable insect fragments; 5, fish remains; and 6, vegetation. The largest fish (570 mm.) contained prawns and one *Kryptopterus*. Three specimens collected in a small tributary at Pintasan but not preserved contained crabs, *Clarias*, and *Kryptopterus*.

Localities.—Kinabatangan District, Deramakot (66), Sungei Gaja (21), Danau Bukit Garam (1), Lamag (1), below mouth of Sungei Malubok (4), tributary of Kinabatangan River one mile above Sungei Tabalin Besar (2), Sungei Pinang (24); Kota Belud District, Tempasuk River (1); Labuk and Sugut District, Labuk River (3); Sandakan District, Sungei Gum Gum (3), Mile 16, Labuk Road, Sandakan (4); Tambunan District, Sungei Kaingeran (1); Tawau District, Kalabakan River (1), Sungei Marikut (30), Sungei Tawan (71); Tuaran District, Tuaran River at Kiulu (15).

Mystus baramensis (Regan). Figure 70.

Macrones baramensis Regan, 1906, Ann. Mag. Nat. Hist., (7), **18**: 68—Baram River, Sarawak; Weber and de Beaufort, 1913, Fishes Indo-Austr. Arch., **2**: 338; Hardenberg, 1936, Treubia, **15**: 234.

Mystus baramensis Herre and Myers, 1937, Bull. Raffles Mus., no. 13, p. 68.

Dorsal II,7; pectoral I,8–10 (mean I,9.1; N=26); ventral i,5; anal iii–vi,8–10 (mean of branched rays 8.1; N=26); gill rakers 3–7+12–17, total 15–24 (mean total 20.6; N=21); branchiostegals 10–13 (mean 11.3; N=19); head 0.275–0.318 (median 0.297; N=25); depth 0.187–0.216 (median 0.201; N=13); eye 0.045–0.056; anal in adipose 1.39–2.13 (median 1.75; N=24); adipose base 0.181–0.247 (median 0.211; N=28); standard length 31.2–172.0 mm.; total length to 212 mm.

Nasal barbel reaching hind border of eye; maxillary barbel reaching middle or end of adipose fin.

Fishes from streams draining into Sandakan Harbour and immediately north of Sandakan differ slightly from those of the Kalabakan River drainage (see Table 10). These populations are so close geographically that nomenclatorial recognition of this slight variation is not warranted.

TABLE 10.—Comparison of Samples of *Mystus baramensis* from Two Areas in Eastern North Borneo

	Sandakan area	Kalabakan area
Anal fin	iii–iv,8(10),* 9(5), 10(3)	v–vi,8(7), 9(3)
Pectoral fin	I,8(8), 9(7), 10(3)	I,9(1), 10(9), 11(1)
Branchiostegals	10(5), 11(2)	10(2), 11(2), 12(6), 13(3)
Gill rakers	15(1), 18(2), 19(5), 20(1)	19(1), 21(3), 22(4), 23(3), 24(1)

* Number in parentheses refers to number of specimens with given count.

This species is readily distinguished from *nemurus*, the form it resembles the most, by coloration, counts, and body proportions. *Mystus nemurus* at all sizes has a thin, black mid-lateral stripe and

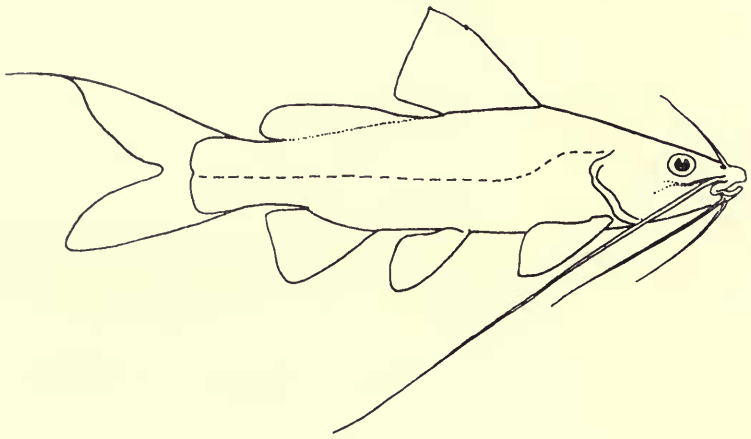

FIG. 70. *Mystus baramensis.*

usually a black spot at the end of the adipose fin; *baramensis* lacks these markings. The narrowest part of the caudal peduncle is equal to the preorbital length of the head in *baramensis* but is narrower than that in *nemurus*. Differences in the relative length of anal and adipose are brought out by the statistics given for each species. Though the total number of gill rakers in *nemurus* has about the same range (13–20) as in the Sandakan area *baramensis* (15–20), the modal values are 15 and 19, respectively.

This species can be distinguished from *Mystus sabanus* by its relatively short adipose fin and its shorter nasal barbel.

Despite intensive fishing in the Kinabatangan basin, *baramensis* has not been obtained there, though it has been collected in drainages

to the north and south. The geographic variation of the two samples of *baramensis* seen and its absence from the Kinabatangan suggest that the species may have reached eastern North Borneo from two directions: from the northwest and from the southeast.

Only six stomachs contained food remains. The food fragments were exclusively arthropod and included decapod crustaceans in three cases. Of the 43 specimens we collected, 42 were caught in small, gravel-bottomed streams having clear water. The exceptional fish was caught with a cast net in the Kalabakan River, which is about 25 meters wide.

Localities.—Labuk and Sugut District, Banin-banan (1); Sandakan District, Sungei Kabili (12), unnamed tributary of Sungei Sapagaya (9), Sungei Sibuga (2); Tawau District, Kalabakan River (1), Sungei Marikut (13), Sungei Tawan (20).

Mystus planiceps (Valenciennes). Figure 71.

Bagrus planiceps Valenciennes *in* Cuvier and Valenciennes, 1839, Hist. Nat. Poissons, **14**: 421—Java.

Mystus planiceps Herre and Myers, 1937, Bull. Raffles Mus., no. 13, p. 69.

Macrones planiceps Weber and de Beaufort, 1913, Fishes Indo-Austr. Arch., **2**: 342.

Dorsal II,7; pectoral I,9; ventral i,5; anal iii–v,9–11, total rays 13–16 (mean total 14.3; N=14); gill rakers 3–5+12–15, total 15–20

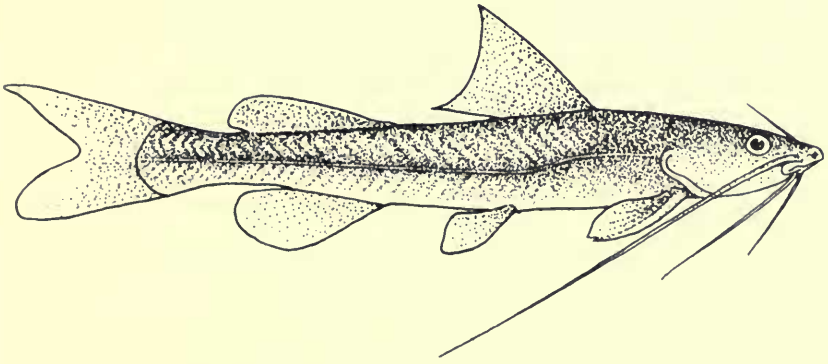

FIG. 71. *Mystus planiceps.*

(mean total 17.0; N=14); branchiostegals 10–12 (mean 11.5; N=11); head 0.243–0.286 (median 0.255; N=13); depth 0.127–0.155 (median 0.143; N=7); eye 0.039–0.054 (median 0.045; N=10); interorbital

0.074–0.081 (median 0.078; N=9); standard length 71.9–225.0 mm.; total length 93–275 mm. (The above data are from specimens collected in the Baleh River, Third Division, Sarawak.)

Color in alcohol dark slate brown above, lighter on lower portion of side and belly; no stripe on side; fins dusky, pectoral and ventral lighter than others.

Locality.—Kudat District, Bongon (Boulenger, 1894).

Leiocassis robustus Inger and Chin

Leiocassis robustus Inger and Chin, 1959, Fieldiana: Zool., **39**: 290, fig. 48—Deramakot, Kinabatangan District, North Borneo.

Dorsal II,7; pectoral I,8–9 (one with 8; N=8); ventral i,5; anal v–vi,10–11 (mean branched rays 10.6; N=8); gill rakers 5–8+12–15, total 19–22 (mean total 20.2; N=7); serratures on pectoral spine 18–32; head 0.251–0.275; depth 0.248–0.311; snout 0.090–0.105 (median 0.099; N=5); length of dorsal spine 0.203–0.236 (median 0.222; N=8); adipose base 0.186–0.237; dorsal-adipose distance 0.075–0.149 (median 0.129; N=8); standard length 103.5–250 mm.; total length 136–307 mm.

Color in life dark reddish brown, lighter below; no dark spots or bands; in alcohol uniform slate gray, lighter below; fins dusky.

As shown by Inger and Chin (1959), increase in standard length is accompanied by an increase in the number of serratures on the pectoral spine, a relative reduction in head length, a relative widening of the head (shown both by overall head width and by interorbital width), a relative increase in body depth, and a relative increase in the length of the adipose fin.

This catfish has been collected only in the muddy water of the Kinabatangan River, despite intensive fishing in small, clear tributaries. Six specimens were caught on hook-and-line baited with earthworms and while the Kinabatangan was in flood. The local river people maintain that this species can be caught only at high water.

Local name.—"Kokok" (Orang Sungei).

Localities.—Kinabatangan District, Kinabatangan River at Deramakot (6) and at Lamag (1).

Leiocassis poecilopterus (Valenciennes)

Bagrus poecilopterus Valenciennes *in* Cuvier and Valenciennes, 1839, Hist. Nat. Poissons, **14**: 431—Java.

Leiocassis poecilopterus Bleeker, 1858, Ichth. Arch. Ind. Prodr., I Siluri, p. 140; Weber and de Beaufort, 1913, Fishes Indo-Austr. Arch., 2: 356.

Dorsal II,7; pectoral I,8–9; ventral i,5; anal v,9–11; caudal i,14–15,i; gill rakers 3–4+9–11, total 12–15; serratures on pectoral spine 15–18; head 0.284–0.303; depth 0.250–0.270; head width 1.53–1.70 in head length, head height 1.72–1.78 in head length; base of adipose 0.140–0.159; base of dorsal 1.22–1.48 in adipose; dorsal-adipose distance 0.77–1.00 in adipose; standard length 141–158 mm.; total length to 202 mm.

Maxillary barbel reaching between eye and end of preopercle; nasal barbel extending to rear margin of eye or slightly beyond; mental barbels shorter than maxillary.

In alcohol color of top of head and vertebral region dark brown; a dark brown band from dorsal base to ventral insertion, widest mid-laterally; another from adipose to anal, widest mid-laterally, usually interrupted by lighter ground color between lateral line and anal base; caudal peduncle almost entirely dark brown except for a light mid-lateral streak and a light vertebral spot between caudal and adipose; all fins with dark bases and inframarginal bands.

These descriptive notes are based on four specimens from a small tributary in the Rejang River drainage of Sarawak. Variation in the shape and length of the occipital process in this small series is extensive and, considering the similarities in standard lengths, is a measure of individual variation rather than growth changes. The pertinent measurements follow:

Standard length	Length of occipital process	Occipital process to basal bone of dorsal	Column 2 over column 3
141	10.7	1.7	6.3
153	12.1	3.5	3.5
158	13.0	2.1	6.2
158	10.2	6.3	1.6

According to Bleeker (1862) the occipital process reaches the base of the dorsal in *poecilopterus;* the differences between that condition and those observed in two of the above fishes are not significant. However, the figures in the last column also cover the differences between *L. saravacensis, L. baramensis,* and *L. merabensis* as given by Regan (1913) and Weber and de Beaufort (1913). The fact that the four species involved here are similar in coloration, counts, and body proportions places the status of the last three in doubt.

Locality.—Beaufort District, Marabah; Kudat District, Bongon (Boulenger, 1894).

Leiocassis micropogon (Bleeker). Figure 72.

Bagrus micropogon Bleeker, 1852, Nat. Tijds. Ned. Indië, **3**: 94—Billiton.

Leiocassis micropogon Bleeker, 1858, Ichth. Arch. Ind. Prodr., I Siluri, p. 142; Weber and de Beaufort, 1913, Fishes Indo-Austr. Arch., **2**: 357.

Dorsal II,7; pectoral I,8–9; ventral i,5; anal iv–vi,10–11 (one with 10; N=5); caudal i,15–16,0–i; gill rakers 3–5+7–9, total 11–13

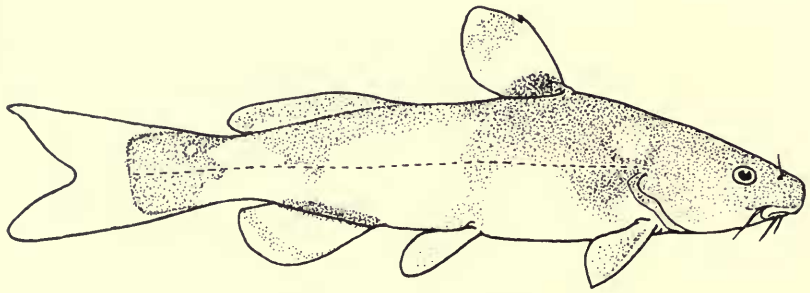

FIG. 72. *Leiocassis micropogon.*

(mean total 11.6; N=5); serratures on pectoral spine 10–11; head 0.271–0.282; depth 0.176–0.199; head width 1.58–1.71 in head length, head height 1.89–1.93 in head length; base of adipose 0.208–0.232; base of dorsal 2.01–2.24 in adipose; dorsal-adipose distance 1.28–1.45 in adipose; standard length 49.4–97.2 mm.; total length 55.2–118.0 mm.

Maxillary barbel extending just beyond perpendicular from rear of eye; nasal barbel barely reaching eye; outer mental barbel not as long as maxillary, inner still shorter.

In alcohol color of head and broad vertebral band dark brown; dark pigment extending ventrad for varying distance between head and end of dorsal; smaller dark area below adipose, continuous with vertebral band; a still smaller dark blotch on caudal peduncle; remainder of sides and ventral surface pale brownish; adipose and base of dorsal dark brown; fins usually with a dusky band.

These fishes agree reasonably well with published descriptions, though their dark areas are much less extensive than those figured by Bleeker (1862, pl. 66). The humeral process is somewhat narrower than the one shown in Bleeker's plate.

These specimens were collected in a small rain forest stream in clear water. One female (92.8 mm.) contained ripe ova.

Locality.—Tawau District, Kalabakan, Sungei Tawan (5).

Leiocassis merabensis Regan

Liocassis merabensis Regan, 1913, Ann. Mag. Nat. Hist., (8), **11**: 550—Marabah, North Borneo.

Leiocassis merabensis Weber and de Beaufort, 1913, Fishes Indo-Austr. Arch., **2**: 359.

Dorsal II,7; anal 14; head 0.27; depth 0.20–0.21; eye 8–9 in head; interorbital 5.5 in head; head width 1.67 in its length; dorsal 1.67–1.75 in adipose; least height of caudal peduncle 2 in its length (after Regan, 1913).

Locality.—Beaufort District, Marabah (op. cit.).

SISORIDAE

Fishes of this family have not been reported previously from North Borneo.

Glyptothorax major (Boulenger). Figure 73.

Akysis major Boulenger, 1894, Ann. Mag. Nat. Hist., (6), **13**: 246—Senah, Tagora River, and Baram River, Sarawak.

Glyptothorax major Smith, 1945, Bull. U. S. Nat. Mus., no. 188, p. 401, fig. 88.

Glyptosternum majus Weber and de Beaufort, 1913, Fishes Indo-Austr. Arch., **2**: 267.

Dorsal II,6; pectoral I,8; ventral i,5; anal iii–v,9–11; gill rakers 3–4+7–8; head 0.265–0.291; depth 0.207–0.233; eye 0.019–0.033;

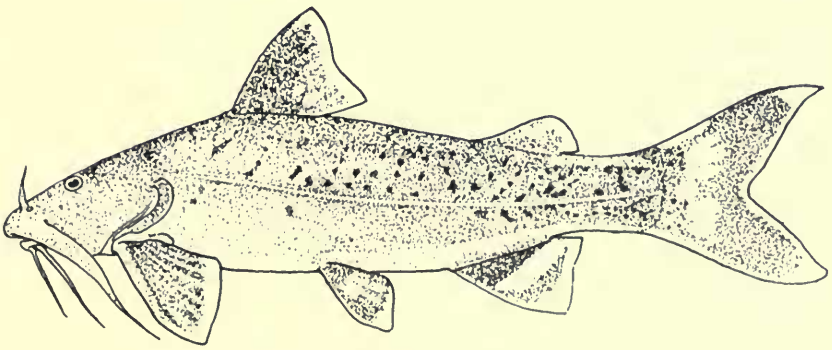

FIG. 73. *Glyptothorax major.*

adipose base 0.148–0.166; dorsal-adipose distance 0.225–0.236; standard length 56.0–113.2 mm.; total length 74–141 mm.

Nasal barbel reaching half the distance to orbit; maxillary barbel reaching to slightly beyond base of pectoral; mandibular barbel reaching to base of pectoral; mental barbel two-thirds of length of mandibular.

Color in alcohol slate brown above and on sides; belly whitish; fins dark brown with light margins; anal with an orange band splitting the dark brown color; caudal with an orange band or two orange spots near base.

Both specimens were taken in clear water over rocky bottoms.

Local names.—"Songar" (Dusun of Kota Belud) and "Goyuntong" or "Payuntong" (Dusun of Tambunan).

Localities.—Kota Belud District, Tempasuk River (1); Tambunan District, Pegalan River (1).

SCHILBEIDAE

Pangasius is the only genus of this family collected so far in North Borneo. The three species now known from the Colony may be separated on the following basis:

1A. Maxillary barbel reaching tip of pectoral spine (fig. 74, A)..... *macronema.*
B. Maxillary barbel at most reaching just beyond base of pectoral.....2.
2A. Eye large, four to five times in length of head (fig. 74, B); vomerine and palatal teeth in transversely elongated groups (fig. 74, D)..... *tubbi.*
B. Eye small, seven to ten times in length of head (fig. 74, C); vomerine and palatal teeth in one large quadrangular mass (fig. 74, E)..... *nieuwenhuisi.*

Fishes of the genus *Pangasius* are called "Lawang" (Malay and Orang Sungei), "Patin" (Malay), "Mantimus" (Orang Sungei at Deramakot), and "Tikol" (Orang Sungei). They are important food fishes along the larger rivers.

Pangasius macronema Bleeker

Pangasius macronema Bleeker, 1851, Nat. Tijds. Ned. Indië, 1: 11—Bandjermasin, Borneo; Weber and de Beaufort, 1913, Fishes Indo-Austr. Arch., 2: 259.

Dorsal II,7; pectoral I,10; ventral i,5; anal v,24; branchiostegals 9; gill rakers 9+11; head 0.260; eye 0.048 (5.4 in head length); anal base 0.267; maxillary barbel reaching to tip of pectoral; mandibular barbel reaching to end of first third of pectoral spine; standard length 70.5 mm.; total length 90.5 mm.

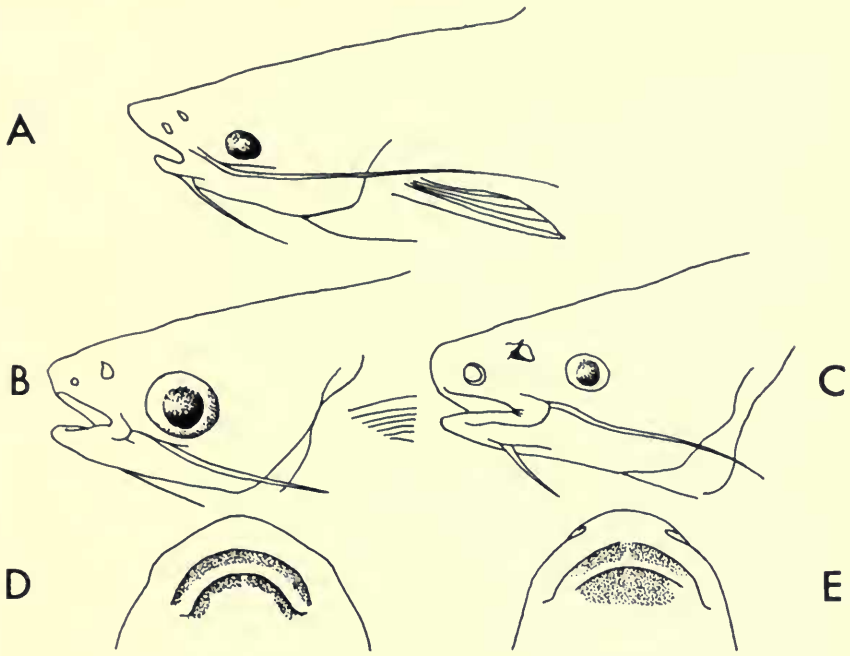

FIG. 74. Key to species of Schilbeidae.

Color grayish above, silvery below; fins without markings.

A single specimen is placed in this species with some hesitation. The long barbels and the disposition of the palato-vomerine teeth in four widely separated groups are the characters suggesting the identification. However, the present specimen has fewer soft pectoral rays (10 as opposed to 12 in the type series), a larger head, and smaller eye than the specimens described by Bleeker (1862) and Weber and de Beaufort (1913). A range of 3 pectoral rays is not unique in the genus, *micronema* having pectoral counts of 11–14 (Weber and de Beaufort, 1913). The difference in head length (0.20–0.22 in *macronema* according to Bleeker, 1862) is slight and may be related to a difference in standard length, our fish being 20 mm. shorter than Bleeker's smallest. But the large difference in eye (2.3–3 in head length in *macronema* according to Bleeker, 5.4 in our fish) cannot be explained in this fashion, as the eye usually decreases relative to the head with an increase in standard length.

The eye in *P. siamensis* Steindachner (type locality Thailand) approaches that of this fish more closely, being 3.3–3.67 in head

length (Steindachner, 1879), but *siamensis* has shorter barbels and a higher anal count. The only other Indo-Malayan species, *P. equilabialis* Fowler (type locality Thailand), with barbels ending near the tip of the pectoral, also has a higher anal count and differs in the palato-vomerine dental arrangement.

Locality.—Labuk and Sugut District, Labuk River (1).

Pangasius tubbi Inger and Chin

Pangasius tubbi Inger and Chin, 1959, Fieldiana: Zool., **39**: 287, fig. 47—Deramakot, Kinabatangan District, North Borneo.

Dorsal II,7–8 (only one with 8 branched rays; N=20); pectoral I,11–12 (mean I,11.7; N=19); ventral i,5; anal iv–vi,33–38, total rays 38–43 (mean total 39.7; N=20); branchiostegals 7–10 (mean 8.5; N=19); gill rakers 3–5+8–12, total 11–17 (mean total 14.0; N=19); head 0.198–0.255 (median 0.227; N=21); depth 0.202–0.251 (median 0.230; N=14); eye 0.040–0.062 (median 0.051; N=16), 3.9–5.0 times in head length; anal base 0.285–0.334 (median 0.300; N=15); standard length 64.5–228.0 mm.

Mandibular barbel reaching below eye.

Color in alcohol grayish, without distinct markings; much lighter on belly; dorsal and caudal faintly dusky; other fins colorless.

The biggest specimen was caught in a trammel net set across the mouth of Sungei Deramakot. One was collected with a seine over a gravel bar and seven with a cast net, all in the Kinabatangan River.

Localities.—Kinabatangan District, Bukit Garam (3), Deramakot (8), Kinabatangan River below mouth of Sungei Malubok (1), Lamag (2), Malapi (1); Lahad Datu District, Segama River at Segama Estate (7).

Pangasius nieuwenhuisi (Popta). Figure 75.

Neopangasius nieuwenhuisi Popta, 1904, Notes Leyden Mus., **24**: 180—Bo River, Borneo.

Pangasius nieuwenhuisi Weber and de Beaufort, 1913, Fishes Indo-Austr. Arch., **2**: 258.

Dorsal II,7; pectoral I,10–12 (mean I,11.2; N=6); ventral i,5; anal iv–v,23–24 (mean total 28.5; N=6); gill rakers 7–8+13–16, total 20–24 (mean total 22.2; N=5); branchiostegals 8–9; head 0.203–0.249; depth 0.240–0.304; eye 0.021–0.032 (7.3–9.6 in head length); anal base 0.239–0.253; standard length 129.5–590 mm.; total length 161–735 mm.

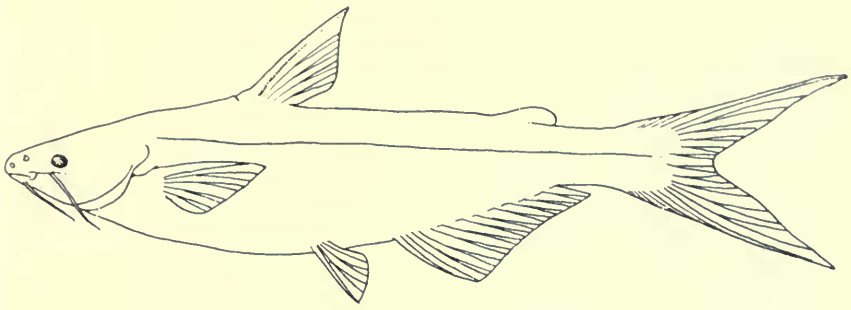

FIG. 75. *Pangasius nieuwenhuisi.*

Mandibular barbel reaching below end of preopercle or end of opercle.

Color grayish above, silvery below; fins without markings.

All specimens seen were collected in the Kinabatangan River. Two were caught with hook-and-line and earthworm bait. The biggest specimen was caught by long line baited with small fish.

Localities.—Kinabatangan District, Deramakot (4), Malapi (2).

ARIIDAE

The fishes of this primarily marine or brackish water family often swim far upstream into fresh water. Probably numerous ariid catfishes are included in the fresh-water fauna of North Borneo but have not yet been caught in such situations.

Of the two genera collected in North Bornean fresh waters, one, *Batrachocephalus*, is immediately distinguished by the wide mouth, which runs back below the eye, by the two pairs of minute barbels under the chin, and by the lack of maxillary barbels. The other genus, *Arius*, has maxillary barbels (fig. 77, A) and a much smaller mouth.

Batrachocephalus mino (Hamilton). Figure 76.

Ageneiosus mino Hamilton, 1822, Fishes of Ganges, p. 159—Ganges.

Batrachocephalus mino Günther, 1864, Cat. Fishes Brit. Mus., **5**: 182; Weber and de Beaufort, 1913, Fishes Indo-Austr. Arch., **2**: 332, fig. 143.

Dorsal II,7; pectoral I,8–9 (mean I,8.4; N=5); ventral i,5; anal iv–vii,13–15, total 19–21; gill rakers 3–4+7–8, total 11–12; head 0.288–0.307; depth 0.222–0.242; snout 0.073–0.081; eye 0.060–0.068; standard length 115.5–153.0 mm.; total length 140–188 mm.

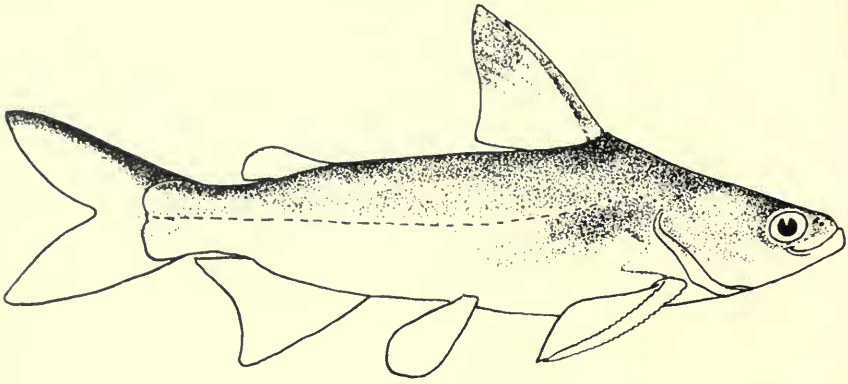

FIG. 76. *Batrachocephalus mino.*

The median pair of mandibular barbels is absent in one specimen.

Color in alcohol grayish above, silvery below; anterior edge of dorsal and upper edge of caudal dark.

The entire series was collected in muddy water in a tributary of the Kinabatangan miles above the reach of tides. All stomachs contained plant material only.

Locality.—Kinabatangan District, Deramakot (5).

Arius

Only two species of this genus are known definitely to occur in North Bornean fresh water. One of them, *microcephalus*, has dusky fins and the teeth of its upper jaw are arranged in a band that is

FIG. 77. Key to species of *Arius.*

roughly three times as wide as deep (fig. 77, B). The second species, *maculatus*, has yellow fins (except for the adipose, which has a black spot) and the upper teeth are in a band approximately six times as wide as deep (fig. 77, C). Additional species probably occur above the tidal zone in the larger rivers.

Local names.—"Utik" or "Badukang" (Malay) is used for small individuals; "Manyong" (Malay) is used for bigger individuals.

Arius maculatus (Thunberg). Figure 78.

Silurus maculatus Thunberg, 1792, Kongl. Vetensk. Acad., Nya Handl., **13**: 31—Japan.

Arius maculatus Weber and de Beaufort, 1913, Fishes Indo-Austr. Arch., **2**: 284.

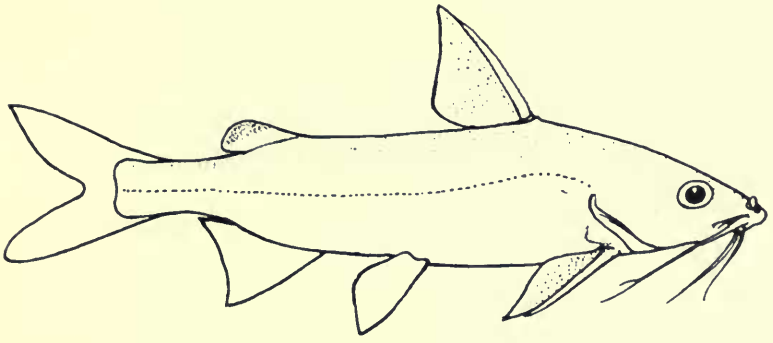

FIG. 78. *Arius maculatus.*

Dorsal II,7; pectoral I,10; ventral i,5; anal v–vii,13–15; gill rakers 7–8+13–15, total 21–22; head 0.290–0.293; depth 0.190–0.198; snout 0.108–0.123; eye 0.041–0.050; standard length 120–186 mm.; total length 154–235 mm.

Both fishes were taken in the Kinabatangan River, the smaller with a cast net in shallow water and the larger with hook-and-line while the river was in flood.

Locality.—Kinabatangan District, Deramakot (2).

Arius microcephalus Bleeker. Figure 79.

Arius microcephalus Bleeker, 1855, Nat. Tijds. Ned. Indië, **9**: 423—Bandjermasin, Borneo; Weber and de Beaufort, 1913, Fishes Indo-Austr. Arch., **2**: 285.

Dorsal II,7; pectoral I,10–11; ventral i,5; anal v–vii,13–15, total 19–21; gill rakers 7+11–13; head 0.271–0.286; depth 0.203–0.242;

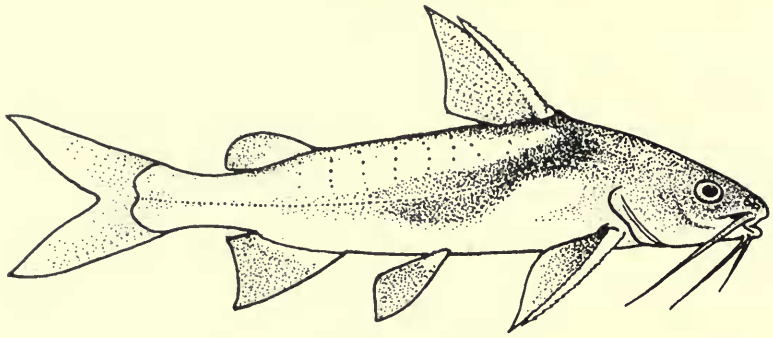

FIG. 79. *Arius microcephalus.*

snout 0.097–0.108; eye 0.045–0.047; standard length 160–253 mm.; total length 200–326 mm.

The maxillary barbel reaches the edge of the gill membrane or just beyond the insertion of the pectoral spine. The palatal teeth are large and molariform.

All were caught in a trammel net at night in the Kalabakan River in the tidal zone. At the point of capture the water is always fresh.

Locality.—Tawau District, Kalabakan (4).

POECILIIDAE

Lebistes reticulatus (Peters)

Poecilia reticulata Peters, 1859, Monatsber. Akad. Wiss. Berlin, **1859:** 412—Caracas, Venezuela.

Lebistes reticulatus Regan, 1913, Proc. Zool. Soc. London, **1913:** 1008.

Dorsal ii,5; pectoral ii,11; ventral i,5; anal ii,8; mid-lateral scales 26–29; maximum standard length of females 27.7 mm., of males 16.2 mm.; maximum total length of females 37.5 mm., of males 22.5 mm.

The guppy, no doubt introduced by an aquarist whose enthusiasm had evaporated, now occurs in several of the small muddy creeks in Sandakan. The exact date of introduction is unknown. Our specimens were collected in 1950.

Locality.—Sandakan District, Sandakan (52).

HEMIRAMPHIDAE

Dermogenys pusillus van Hasselt. Figure 80.

Dermogenys pusillus van Hasselt, 1823, Alg. Konst. Letterbode, **2:** 131—Java; Weber and de Beaufort, 1922, Fishes Indo-Austr. Arch., **4:** 140; Mohr, 1936,

Mitt. Zool. Mus. Berlin, **21**: 41, figs. 1–7; Herre, 1944, Stanford Univ. Publ., (Biol. Sci.), **9**: 43.

Dermogenys orientalis Hardenberg, 1936, Treubia, **15**: 240; 1937, op. cit., **16**: 10.

Dorsal iii–iv,6–7 (mean total rays 9.3; N=15); pectoral i,8–10 (mean i,9.2; N=17); ventral i,5; anal iii–iv,10–13 (mean total rays

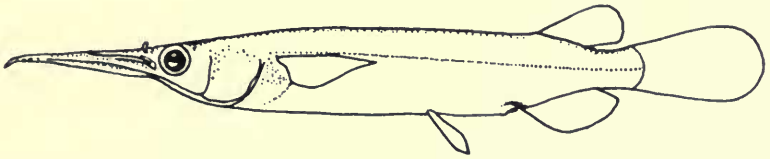

FIG. 80. *Dermogenys pusillus.*

14.6; N=16); mid-lateral scales 44–48; head 0.241–0.272 (median 0.254; N=6); depth 0.130–0.134 (median 0.133; N=3); standard length (with beak) of females 35–57 mm., of males 30–36.5 mm.; maximum total length (with beak) of females 65 mm., of males 42.5 mm.

Color pale yellowish without conspicuous markings.

Many stages of developing embryos may be found within the oviducts of a given female. Ova without visible embryos measured 0.4–0.6 mm., and the smallest eggs containing embryos 0.9–1.2 mm. The largest embryos found measured 14 mm. and had the lower jaw slightly longer than the upper; the yolk sac was still present. Within the oviducts of a 44 mm. female, there were three undeveloped ova (about 0.5 mm.) and nine embryos. The diameters of the egg membranes enclosing these nine measured: one 0.9 mm., four approximately 2.4 mm., and four 4.6–7.0 mm.

Dermogenys is most abundant in brackish water but moves upstream into turbid fresh water. These fishes live in small streams or in large rivers, where they may be seen swimming at the surface near the banks.

Dermogenys evidently feeds on terrestrial invertebrates that fall into the water. Two stomachs contained ants and one a spider.

Local name.—"Jolong-jolong" (Malay).

Localities.—Kinabatangan District, Sungei Gaja (34), Danau Bilit (2), Mintak (1), Sungei Pinang (25), tributary of Sungei Kretam Kechil (7), Deramakot (5), Abai (2); Sandakan District, Gum Gum, Segaliud, and Kabili Rivers (Herre, 1944), Sandakan (16), tributary

of Sungei Sapagaya (2); Tawau District, Kalabakan, Sungei Marikut (1), Pulau Sebatik (2), Sungei Balung and Tawau (Herre, op. cit.).

SYNGNATHIDAE

Doryichthys brachyurus (Bleeker)

Syngnathus brachyurus Bleeker, 1853, Verh. Batav. Gen., **25**: 16 [not seen].

Doryichthys brachyurus Günther, 1870, Cat. Fishes Brit. Mus. **8**: 184.

Microphis brachyurus Weber and de Beaufort, 1922, Fishes Indo-Austr. Arch., **4**: 44, fig. 21.

Dorsal 39–42; pectoral 20–21; anal 4; rings 20+1+22 and 21+22; subdorsal rings 1+8–9; head 0.215–0.229; snout 1.54–1.57 in head; trunk 0.72–0.77 in tail; standard length 124–139 mm.; total length 132–148 mm.

Color in alcohol dark brown.

These fishes were caught in fresh water but within the reach of tidal currents.

Locality.—Kinabatangan District, Sungei Pinang (2).

OPHICEPHALIDAE

The two species of *Ophicephalus* now known to occur in North Borneo can be distinguished on the basis of fin lengths. The pectoral fin of *melanosoma* is approximately the same length as the postorbital part of the head, whereas the fin of *striatus* is distinctly shorter. The two species overlap only slightly in this character. The distance from the anus to the tip of the ventral is equal to or slightly less than the length of the ventral fin in *melanosoma*, but only half the length of the fin in *striatus*. Normally, the former has 15 or 16 pectoral rays, whereas 18 is the usual number in *striatus*. In the samples examined one specimen of each species had 17 rays. Finally, *melanosoma* has a broader and flatter head than *striatus*.

They are among the best-flavored fishes in North Borneo rivers.

Local names (both species).—"Aruan," "Pangal," or "Gapus" (Malay); "Sakak" (Orang Sungei).

Ophicephalus melanosoma Bleeker. Figure 81.

Ophicephalus melanosoma Bleeker, 1851, Nat. Tijds. Ned. Indië, **2**: 424—Sambas, Borneo.

Ophiocephalus melanosoma Günther, 1861, Cat. Fishes Brit. Mus., **3**: 473; Weber and de Beaufort, 1922, Fishes Indo-Austr. Arch., **4**: 319; Herre, 1933, Jour. Pan-Pacific Res. Inst., **8**, no. 4, p. 3.

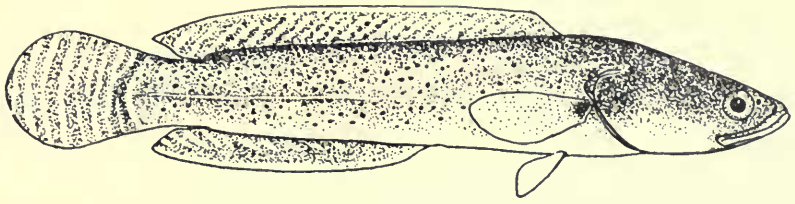

FIG. 81. *Ophicephalus melanosoma.*

Dorsal 37–40 (mean 38.2; N=23); pectoral 14–17 (mean 15.2; N=22); ventral i,5; anal 22–25 (mean 23.0; N=23); lateral line scales 50–54 (mean 51.7; N=23); transverse scales from lateral line to dorsal origin 4–5½, to anal origin 7½; head 0.291–0.331 (median 0.311; N=17); depth 0.152–0.187 (median 0.160; N=13, all specimens over 100 mm.); snout 0.050–0.057 (median 0.052; N=5); eye 0.040–0.048 (median 0.043; N=7); interorbital 0.090–0.093 (median 0.092; N=5); pectoral length in postorbital length of head 0.95–1.15 (median 1.06; N=17); standard length 31.0–285 mm.; total length 36.0–355 mm.

Color in alcohol dark brown above, lighter below; many of the lateral scales with dark central spots; all fins dusky or dark, the caudal usually barred.

Three females (161–204 mm.) had enlarged ova.

This fish was collected in small (3 meters wide) to moderate-sized streams (20 meters wide). It was found in clear (7 specimens) or turbid (36) water and in streams flowing in secondary growth or primary forest.

One fish contained two specimens of *Acanthophthalmus sandakanensis* (20 mm.); another, a specimen of *Rasbora sumatrana;* a third, one lizard (*Tropidophorus*, 37 mm.); a fourth, a crab; and a fifth, ants, insect larvae and fragments of crustaceans.

Localities.—Jesselton District, Menggatal (1); Kinabatangan District, tributary of Sungei Kretam Kechil (3), Deramakot (3); Kota Belud District, Tempasuk River (1); Sandakan District, Sandakan (6), Labuk Road, Mile 5 (7) and Mile 6 (4), Sandala Estate (14), tributary of Sungei Sapagaya (2), Sepilok Forest Reserve (3).

Ophicephalus striatus Bloch. Figure 82.

Ophiocephalus striatus Bloch, 1797, Ichthy., **10**: 117, pl. 359—Malabar; Weber and de Beaufort, 1922, Fishes Indo-Austr. Arch., **4**: 317; Hardenberg, 1936, Treubia, **15**: 242.

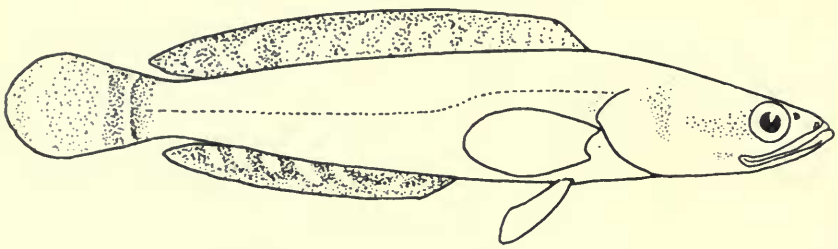

FIG. 82. *Ophicephalus striatus.*

Dorsal 38–41 (mean 39.9; N=10); pectoral 17–18 (mean 17.9; N=10); ventral i,5 (two with i,6); anal 24–26 (mean 25.2; N=10); lateral line scales 49–55 (mean 52.0; N=10); transverse scales from lateral line to dorsal origin 3½–4½, to anal origin 7–7½; head 0.328–0.357 (median 0.343; N=9); depth 0.149–0.205 (median 0.178; N=7, all specimens above 90 mm.); snout 0.049–0.057 (median 0.056; N=5); eye 0.042–0.051 (median 0.044; N=6); interorbital 0.075–0.080 (median 0.078; N=5); pectoral length in postorbital length of head 1.09–1.22; standard length 54.5–263 mm.; total length 67.0–320 mm.

The number of unbranched rays in the dorsal, anal, and pectoral fins varies with size. Adults and sub-adults (150 mm. and over) usually have one unbranched dorsal and pectoral but no unbranched anal rays. Over half of the dorsal and anal rays and two or three pectoral rays are simple in fishes above 90 mm.

Color in alcohol dark brown above, lighter below, often with indistinct dark vertical bars on back and sides; fins dusky.

All of our specimens were collected in turbid water in secondary growth close to the coast. Possibly *striatus* does not invade streams in primary rain forest.

Localities.—Kinabatangan District, Lamag (3); Sandakan District, Labuk Road, Mile 5 (1), Sandala Estate (19).

ANABANTIDAE

KEY TO SPECIES KNOWN FROM NORTH BORNEO

1A. Lateral line much reduced or absent; dorsal origin over anal (fig. 83, A)..2.

B. Lateral line reaching caudal fin (fig. 83, B), interrupted or continuous; dorsal origin various.....3.

2A. Dark longitudinal stripe on side below level of pectoral base; mid-lateral scales 30-31.....*Betta balunga.*

B. No stripe below pectoral base; mid-lateral scales usually 32 or more. *Betta unimaculata.*

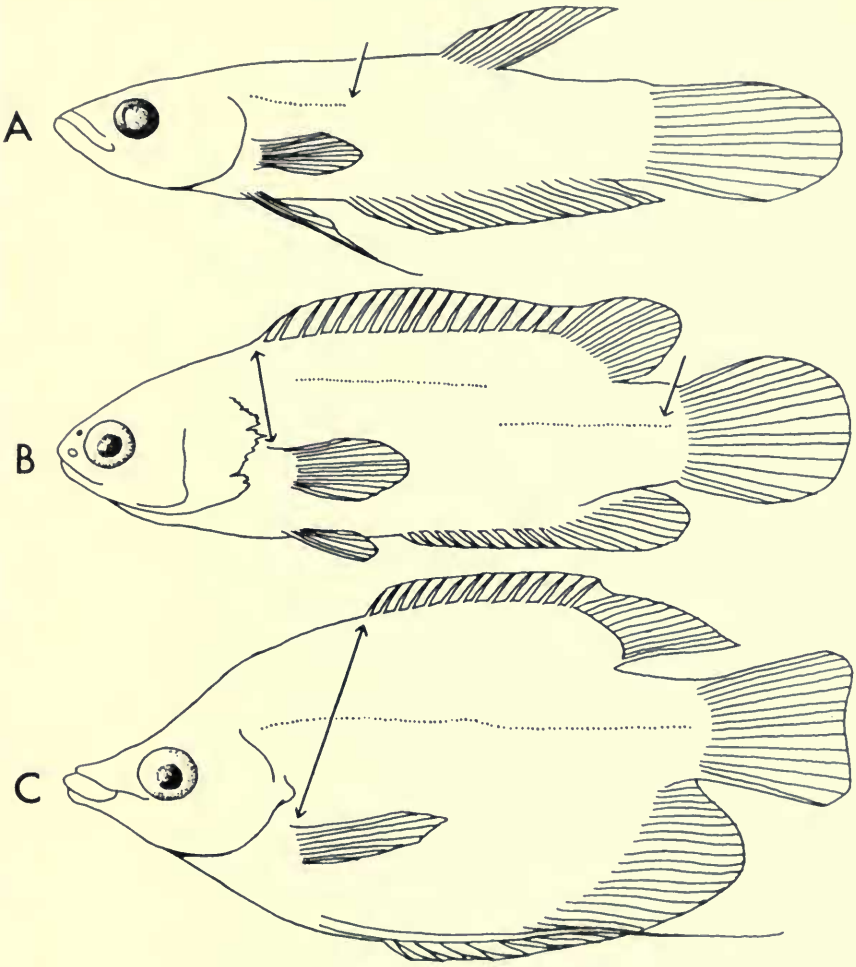

FIG. 83. Key to species of Anabantidae.

3A. Dorsal beginning above base of pectoral (fig. 83, B); first ventral ray not prolonged ..... *Anabas testudineus.*

B. Dorsal beginning well behind base of pectoral (fig. 83, C); first ventral ray a long filament ..... 4.

4A. Fewer than 10 dorsal spines; 3 soft ventral rays ... *Trichogaster trichopterus.*

B. More than 10 dorsal spines; 5 soft ventral rays ..... *Osphronemus goramy.*

Betta balunga Herre

Betta balunga Herre, 1940, Bull. Raffles Mus., no. 16, p. 44—Balung River, North Borneo.

Dorsal I,7; pectoral i,12; ventral ii,4; anal 28–29; mid-lateral scales 30; predorsal scales 27–30; head 0.363–0.380; depth 0.295–0.300; predorsal length 0.704–0.705; standard length 35.5–49.0 mm.; total length 48.0–68.0 mm.

This species differs from *unimaculata* (Popta) in several characters. *Betta balunga* has a dark longitudinal stripe beginning below and behind the pectoral base and continuing as far as the center of the anal or beyond; *unimaculata* has no stripe below the pectoral. The two forms also differ in mid-lateral scale counts (*balunga* 30–31; *unimaculata* usually 32–35, rarely 31), position of the dorsal origin (*balunga* opposite 14th–17th mid-lateral scale; *unimaculata* opposite 18th–20th, rarely opposite 17th), and depth of body (*balunga* 0.295–0.300; *unimaculata* 0.210–0.289).

Herre (1940b) states that the type has three anal spines. All anal rays in the two topotypes examined are segmented. It is probable that all diagnoses and keys to this genus using dorsal or anal "spines" are based upon a misconception. The anterior rays in the dorsal and anal fin may be simple and non-segmented or simple and segmented. Furthermore, they usually consist of paired rods. In the latter case they do not fit Hubbs's definition (1944) of spines. The skin covering these anterior rays, which are usually small, obscures the segmentation. This fact and the occurrence of individual variation in these rays require a complete review of specific distinction in *Betta*.

Locality.—Tawau district, Sungei Balung (2).

Herre (1940b, p. 43) says that the Balung River is 45 miles north of Tawau. This would place it in the Segama River basin and less than 30 miles from Lahad Datu. We find no Balung River in that position on available maps. However, there is a Balung River about 12 miles due east of Tawau. We presume this is the type locality.

Betta unimaculata (Popta)

Parophiocephalus unimaculata Popta, 1906, Notes Leyden Mus., **27**: 10—Howong and Kajan Rivers, Borneo.

Betta unimaculata Regan, 1910, Proc. Zool. Soc. London, **1909**: 779; Weber and de Beaufort, 1922, Fishes Indo-Austr. Arch., **4**: 355.

Betta ocellata de Beaufort, 1933, Bull. Raffles Mus., no. 8, p. 35—Betotan River, North Borneo; Herre, 1940, Bull. Raffles Mus., no. 16, p. 43.

Dorsal 0–I,6–8, total 6–9 (mean total 8.1; N=37); pectoral i–ii, 11–14, total 12–15 (mean total 13.5; N=36); ventral ii,4; anal 0–I, 26–33, total 27–33 (mean total 29.7; N=36); mid-lateral scales 31–

35 (mean 33.3; N=37); predorsal scales 27–31 (mean 28.9; N=33); head 0.317–0.367 (median 0.342; N=35); depth 0.210–0.289 (median 0.249; N=34); snout 0.066–0.102 (median 0.075; N=14); eye 0.066–0.083 (median 0.080; N=7); interorbital 0.103–0.121 (median 0.115; N=7); predorsal length 0.671–0.729 (median 0.701; N=33); standard length 17.8–82.5 mm.; total length 22.5–109.2 mm.

Color in alcohol dark brown above, lighter below; opercle and throat blackish (male dark blue in life); a dark spot at caudal base just below mid-lateral line; under certain conditions a dusky lateral band from opercle to tail base between mid-lateral line and base of pectoral; fins dusky.

From a comparison of the original descriptions, one concludes that *unimaculata* (Popta) and *ocellata* de Beaufort differ chiefly in the relative lengths of the maxillae, the segmentation of the first anal ray, and the color at the base of the tail. Dr. Boeseman, Rijksmuseum, Leiden, informs us that in the type series of *unimaculata* the maxilla, though usually ending below the front border of the orbit, may reach opposite the pupil and thus equal the maxillary length in the single type of *ocellata*.

Dr. Boeseman also finds that the first anal ray in the type series of *unimaculata* may be segmented or not. In the type and two topotypes (the last collected by Herre) of *ocellata*, the first anal ray is non-segmented. The first two anal rays of *ocellata* were described as spines. Microscopic examination of the topotypes reveals that these rays are composed of a pair of rods and hence are non-segmented soft rays rather than spines (see Hubbs, 1944).

The type of *ocellata* was said to have a light-rimmed dark ocellus on the caudal base. This is represented in the topotypes by a black

TABLE 11.—Variation in Samples of *Betta unimaculata* (Popta)

"Spine" refers to anterior non-segmented ray. The number of specimens is given in parentheses.

Locality	Dorsal spine	Anal spine	End of maxilla
Sandakan	present (3)	present (3)	front border orbit (3)
Sungei Bettotan	absent (2)	absent (2)	pupil (2)
Sungei Kabili	absent (1) present (1)	absent (2)	front border orbit (3) pupil (1)
Sungei Sapagaya	absent (7) present (2)	absent (3) present (6)	front border orbit (6) pupil (1)
Kretam Kechil drainage	absent (1) present (9)	present (10)	front border orbit (1) pupil (9)
Sungei Balung	absent (3) present (5)	absent (6) present (2)	front border orbit (6) pupil (2)

spot. A black spot without a light annulus is also characteristic of the types of *unimaculata*.

The variation in these characters suggests that the distinction between the two nominate forms is invalid. This conclusion is borne out by a comparison of six samples from eastern North Borneo (Table 11).

Only the males have dark opercles and throats in life. Enlarged ova were found in females 59.7–72.0 mm. long.

In the Kretam Kechil drainage *unimaculata* was most abundant toward the headwaters of the forest streams, being found farther upstream than any other fish in the drainage. It commonly occurred in the zone in which the streams consist of small pools connected only by trickles of water over steps in the bed rock, and even farther upstream at the sources where the flow is intermittent.

The terrain in the Kretam area is very rough and the stream sources are usually in steep, narrow ravines. After torrential rains, which fall frequently even in the "dry" season of eastern North Borneo, these ravines are scoured out by the rapid and heavy runoff. It is likely that periodically the population of *unimaculata* in these stream sources is reduced and that many pools are devoid of fishes. In order to exploit this habitat, *Betta* must reinvade many pools that are above low waterfalls 15 to 45 cm. high. Actually, the initial invasion of some of the stream sources we examined required the surmounting of sheer rock faces of much greater height. In one case specimens were found above a 2-meter fall and in another above a 5-meter fall. Inspection of this physiographically young area eliminates the possibility that stream piracy accounts for the distribution of *unimaculata* around these "barriers."

Of the various fresh-water fishes collected in the Kretam Kechil drainage, *unimaculata* displayed the most active and effective jumping behavior. Ordinarily, as the fishes were caught they were put into a straight-sided pail 25 cm. high. More individuals of *unimaculata* than of any other species succeeded in leaping out of the pail and *unimaculata* was one of the least numerous forms obtained. This jumping ability undoubtedly accounts for the ability of *unimaculata* to overcome small rock faces in its dispersal upstream. The jumping propensity is also involved in getting *around* the higher waterfalls, but in this problem the ability of the labyrinthine fishes to breathe atmospheric oxygen is probably of equal importance.

Only one adult *unimaculata* and often one or two juveniles occupied each of these small, semi-isolated, upland pools (usually about

60 by 100 cm. at the surface and up to 15 cm. deep). Limitations of the food supply and the known pugnacity of *unimaculata* probably explain the isolation of the adults.

These small pools were devoid of living vegetation, but the bottoms were covered by dead leaves and usually one or more leaves floated on the surface. Adults often hid under a floating leaf. If such a leaf were moved slowly across the surface, the fish *Betta* followed under it. In this way an adult could be led all about the pool and over the deeper portions where a dip-net could be used effectively. But this behavior probably protects the fish from the sight of most predators, which are terrestrial in this reach of the stream, and enables it to live in a relatively exposed habitat.

The diet consists mostly of terrestrial insects, though aquatic invertebrates are also eaten (Inger, 1955).

Local name.—"Pelaga" (Malay) may apply to any species of this genus.

Localities.—Kinabatangan District, Sungei Gaja (29), Sungei Pinang (8), Deramakot (42), unnamed tributary of Sungei Kretam Kechil (24); Kudat District, Sungei Bongon (Regan, 1910); Sandakan District, Sungei Bettotan (2), Sungei Gum Gum (Herre, 1940b), Sungei Kabili (8), tributary of Sungei Sapagaya (13), Labuk Road, Mile 6 (4) and Mile 7 (2), Sandala Estate (5), Sepilok Forest Reserve (10), Tenosa (2); Semporna District, Sungei Mapat (Herre, 1940b); Tawau District, Sungei Balung (8), Sungei Kinabutan (3), Brantian River Estate (2), Kalabakan, Sungei Tawan (2), Pulau Sebatik (5).

Anabas testudineus (Bloch). Figure 83, B.

Anthias testudineus Bloch, 1792, Ausländ. Fische, **6**: 121—Japan.

Anabas testudineus Cuvier, 1817, Régne Anim., ed. 1, **2**: 310; Weber and de Beaufort, 1922, Fishes Indo-Austr. Arch., **4**: 334, fig. 86; Hardenberg, 1936, Treubia, **15**: 243; 1937, op. cit., **16**: 11.

Dorsal XVII–XIX,7–10 (mean spines 17.9; mean rays 8.9; N=13); pectoral i,12–14 (mean i,13.4; N=13); ventral I,5; anal IX–XI,9–11 (mean spines 9.9; mean rays 9.7; N=12); lateral line scales 27–29 (mean 28.5; N=12); head 0.346–0.411 (median 0.367; N=11); depth 0.318–0.408 (median 0.345; N=10); snout 0.051–0.064 (median 0.057; N=7); eye 0.077–0.101 (median 0.084; N=7); interorbital 0.118–0.125 (median 0.123; N=7); standard length 22.5–103.6 mm.; total length 29.0–133.0 mm.

Four specimens from Kota Belud on the West Coast have fewer spines than those from the Sandakan area. Dorsal spine counts in

the former are 17 (3 specimens) and 18 (1), whereas they are 18 (7) and 19 (2) in the Sandakan sample. Anal spines in the two series are respectively 9 (3) and 10 (1), and 10 (7) and 11 (2).

Color in alcohol dark brown, with or without obscure marking on the body; a black spot just behind the opercle and another at the base of the caudal peduncle.

Anabas testudineus is common in small streams in secondary growth and in ditches around the rice fields. Occasionally after heavy rains it can be seen in numbers moving across the open fields covered by a few centimeters of water. During protracted dry periods it buries itself in mud.

Local name.—"Garok" or "Karok" (Malay and Dusun).

Localities.—Jesselton District, Jesselton (26), Menggatal (15); Kota Belud District, Kota Belud (4); Ranau District, Ranau (2); Sandakan District, Labuk Road, Mile 2 (2), Mile 5 (3), Mile 13 (2), Sandala Estate (2).

Trichogaster trichopterus (Pallas). Figure 84.

Labrus trichopterus Pallas, 1770, Spic. Zool., **8**: 45—no locality given.

Trichogaster trichopterus Bloch and Schneider, 1801, Syst. Ichthy., p. 165.

Trichopodus trichopterus Weber and de Beaufort, 1922, Fishes Indo-Austr. Arch., **4**: 366, fig. 93; Hardenberg, 1936, Treubia, **15**: 243.

Dorsal VI–VII,7–9 (mean spines 6.5; mean rays 8.1; N=15); pectoral ii,8–9 (mean ii,8.6; N=13); ventral I,3; anal XI–XIII,32–35 (mean spines 12.0; mean rays 33.5; N=15); lateral line scales 32–36

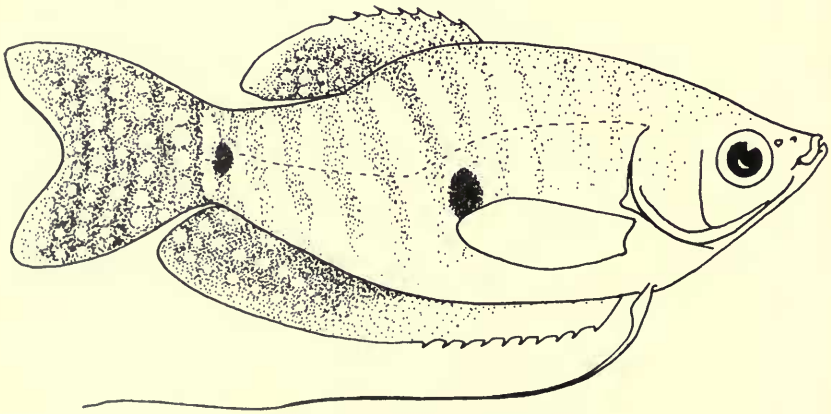

FIG. 84. *Trichogaster trichopterus.*

(mean 34.5; N=12); head 0.300–0.336 (median 0.324; N=12); depth 0.362–0.455 (median 0.416; N=7); snout 0.062–0.076 (median 0.068; N=6); eye 0.094–0.115 (median 0.098; N=6); interorbital 0.121–0.128 (median 0.125; N=6); standard length 34.4–55.0 mm.; total length 46.0–72.0 mm.

Color in alcohol brownish with two black spots, one in center of body and one at base of caudal; vertical fins spotted with dark pigment.

This species is most abundant in the drainage ditches of the rice fields.

Local name.—"Sepat-sepat" (Malay and Dusun).

Localities.—Jesselton District, Inanam (24), 8 miles north of Jesselton (20), Menggatal (15); Kota Belud District, Kota Belud (9); Tuaran District, Tuaran (2).

Osphronemus goramy Lacépède. Figure 83, C.

Osphronemus goramy Lacépède, 1802, Hist. Nat. Poissons, **3:** 116—China and Batavia, Java; Weber and de Beaufort, 1922, Fishes Indo-Austr. Arch., **4:** 344, fig. 89; Hardenberg, 1936, Treubia, **15:** 243.

Dorsal XII–XIV,10–11 (mean spines 13.1; mean rays 10.3; N=6); pectoral ii,11–13 (mean ii,12; N=6); ventral I,5 (N=6); anal X–XI, 17–18 (mean spines 10.6; mean rays 17.3; N=6); lateral line scales 28–33 (mean 30.8; N=6); transverse scales 4–5/1/13½–14½; head 0.316–0.418, the head becoming relatively shorter as the fish grows; depth 0.411–0.529 (median 0.505; N=5); snout 0.068–0.107 (median 0.082; N=5); eye 0.061–0.129 (median 0.085; N=5); interorbital 0.118–0.129 (median 0.122; N=5); standard length 27.0–200 mm.; total length 34.5–260 mm.

Color in alcohol brownish; base of pectoral with a black semicircular spot; juveniles with a series of vertical dark stripes on sides. Stripes disappear in fishes from the Kinabatangan basin when they reach 125 mm. long, but they persist beyond that length in fishes from the Kalabakan drainage.

Weber and de Beaufort (1922) gave 19–21 as the number of soft anal rays.

This species lives in turbid water of cut-off meanders and of large rivers in which it avoids the current by remaining in deep pools. Large individuals are frequently seen near the surface. The gorami feeds mostly on vegetable matter, though insects are also eaten. It is reared in ponds in all districts of North Borneo.

Local names.—"Kului" or "Gorami" (Malay and Dusun).

Localities.—Kinabatangan District, Bilit (3), Sungei Deramakot (4), Lamag (1), Danau Duadan (1); Lahad Datu District, cut-off meander of Segama River at Segama Estate (1); Tawau District, Kalabakan River at the mouth of Sungei Maga (1).

AMBASSIDAE

Ambassis interrupta Bleeker

Ambassis interrupta Bleeker, 1852, Nat. Tijds. Ned. Indië, **3**: 696—Wahai, Ceram and Batavia, Java; Weber and de Beaufort, 1929, Fishes Indo-Austr. Arch., **5**: 415; Hardenberg, 1936, Treubia, **15**: 245; 1937, op. cit., **16**: 11.

Dorsal VIII,9; pectoral ii,12–14 (mean ii,13.1; N=9); ventral I,5; anal III,8–9 (only one with 8; N=9); lateral line scales 19–23 (mean 21.6; N=7); predorsal scales 14–17 (mean 15.7; N=9); head 0.387–0.420 (median 0.401; N=8); depth 0.418–0.483 (median 0.454; N=7); standard length 35.5–56.0 mm.; total length 44–71 mm.

The counts and measurements include individuals collected in brackish water.

Specimens collected in fresh water were feeding on young fishes and terrestrial insects (Inger, 1955).

Locality.—Kinabatangan District, Sungei Gaja (2).

NANDIDAE

Nandus nebulosus (Gray). Figure 85.

Bedula nebulosus Gray, 1833–34, Illust. Indian Zool., pl. 88, fig. 2—locality not given.

Nandus nebulosus Bleeker, 1852, Nat. Tijds. Ned. Indië, **3**: 92; Weber and de Beaufort, 1936, Fishes Indo-Austr. Arch., **7**: 477, fig. 94; Hardenberg, 1936, Treubia, **15**: 250.

Dorsal XIV–XV,10–12 (only two with 15 spines; mean soft rays 11.1; N=15); pectoral ii,13–14 (mean ii,13.6; N=11); ventral I,5 (N=12); anal III,6–8 (mean III,6.7; N=14); lateral line scales 31–36 (mean 34.2; N=15); transverse scales between lateral line and origin of dorsal 4½–5; head 0.369–0.413 (median 0.402; N=16); depth 0.371–0.437 (median 0.403; N=16); snout 0.087–0.102 (median 0.094; N=7); eye 0.098–0.119 (median 0.105; N=7); interorbital 0.069–0.095 (median 0.080; N=7); standard length 46.0–83.8 mm.; total length 58.0–106.0 mm.

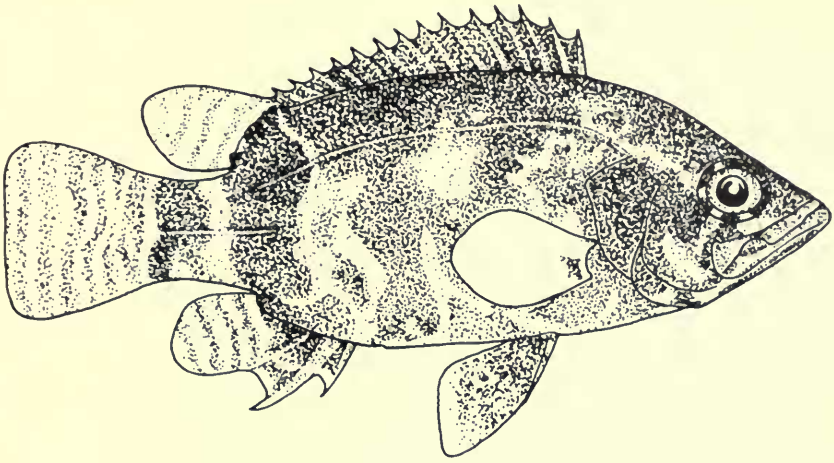

FIG. 85. *Nandus nebulosus.*

In alcohol body mottled with light and dark shades of brown; spinous dorsal and ventral fins heavily marked with dark brown; soft dorsal, anal, and caudal with paler dark spots.

Mature males (longer than 49 mm.) had coarsely serrated preopercular margins and ventrals that reached the anus. Two females with enlarged ova measured 81.2 and 83.8 mm.; their ventral fins did not reach the anus, and the margins of their preopercles were finely serrated.

All our specimens were caught in very slowly moving water of shallow streams in swampy forested areas. At one locality no fishes were seen in the clear water, but ten were collected hiding in dead leaves that covered the bottom.

The digestive tracts of three fishes contained aquatic organisms: dipterous larvae, Plecoptera nymphs, Psephenidae larvae, and one unidentifiable fish.

Localities.—Kinabatangan District, Deramakot (7); Sandakan District, Labuk Road, Sandakan, Mile 16 (10).

TOXOTIDAE

Toxotes chatareus (Hamilton)

Coius chatareus Hamilton, 1822, Fishes of Ganges, p. 101, pl. 14, fig. 34—Ganges River, India.

Toxotes chatareus Bleeker, 1875, Versl. Meded. Akad. Wetens. Amsterdam (2), 9: 160; Weber and de Beaufort, 1936, Fishes Indo-Austr. Arch., 7: 203, fig. 53A, B, and C.

Dorsal V,13; pectoral i,12; ventral I,5; anal III,17; lateral line scales 32–33; transverse scales between lateral line and origin of dorsal 5; head 0.364–0.368; depth 0.462–0.484; snout 0.085–0.086; eye 0.086–0.091; interorbital 0.116–0.117; standard length 157.5–159.0 mm.; total length 190.0–193.0 mm.

Color in alcohol olive gray above, silvery below; a round black spot at upper margin of opercle; a row of five or six round black spots on body above lateral line; dorsal and anal fins dusky or blackish, dorsal often with two brownish black spots.

The female (159 mm.) contained enlarged ova.

Though more abundant in brackish water, *chatareus* also moves upstream into fresh water. Our two specimens were caught in turbid water at the mouth of Sungei Deramakot.

Both specimens had eaten terrestrial invertebrates. One contained a single ant. The other contained four adult Orthoptera (25–35 mm.), one Blattaria (27 mm.), one ant (15 mm.), and two spiders (10 mm.).

Local name.—"Sumpit-sumpit" (Malay and Dusun).

Locality.—Kinabatangan District, Deramakot (2).

SCIAENIDAE

Johnius semiluctuosus (Cuvier)

Corvina semiluctuosa Cuvier *in* Cuvier and Valenciennes, 1830, Hist. Nat. Poiss., 5: 72, fig. 106—Goa, India.

Johnius semiluctuosa Kner, 1865–1867, Novara-Exp., Fische, p. 124.

Johnius semiluctuosus Weber and de Beaufort, 1936, Fishes Indo-Austr. Arch., 7: 535.

Dorsal XI,28–30; pectoral i,17; ventral I,5; anal II,7–8; lateral line scales 48–49; head 0.260; depth 0.325; snout 0.065; eye 0.035; interorbital 0.081; standard 420–540 mm.; total length 506–631 mm.

One specimen (538 mm.) weighed 2.5 kilograms.

Our three specimens were caught in a trammel net that was set across the Kalabakan River at a point where it was about 4.5 meters deep at high tide but beyond the reach of the saline water.

One stomach contained 3 partly digested blind gobies (*Taenioides cirratus*).

Local name.—"Jarau" (Malay).

Locality.—Tawau District, Kalabakan River at Sungei Tibas (3).

LUTIANIDAE

Lutianus argentimaculatus (Forskål)

Sciaena argentimaculatus Forskål, 1775, Descr. Anim., p. 47—Red Sea.

Lutianus argentimaculatus Day, 1875, Fishes of India, p. 37, pl. 11, fig. 5.

Dorsal X,12; pectoral ii,14; ventral I,5; anal III,8; lateral line scales 50; head 0.358; depth 0.358; snout 0.119; eye 0.055; interorbital 0.083; standard length 460 mm.

When caught at sea this fish is usually red or maroon. When caught in fresh water, it is usually greenish.

Our specimen was caught at the mouth of Sungei Deramakot by hook-and-line baited with a small catfish (*Ompok* sp.).

Local names.—"Merah" (Malay), "Tamaing" (Orang Sungei).

Locality.—Kinabatangan District, Deramakot (1).

ELEOTRIDAE[1]

KEY TO SPECIES KNOWN FROM FRESH WATERS OF NORTH BORNEO

1A. Sides of head and borders of jaws with cutaneous flaps or papillae (fig. 86, A). *Prionobutis dasyrhynchus.*

B. Head without such appendages....2.

2A. Preopercle with a decurved spine usually covered by skin (fig. 86, B)....3.

B. Head without spines....4.

3A. Mid-lateral scales 55 or less; two or three scales separating bases of dorsal fins. *Eleotris melanosoma.*

B. Mid-lateral scales more than 55, usually 60 or more; bases of dorsal fins separated by one-half or one scale....*Eleotris fusca.*

4A. Vomerine teeth present; second dorsal with at least 11 rays (including spine). *Bostrichthys sinensis.*

B. Vomerine teeth absent; second dorsal usually with less than 11 rays (including spine)....5.

5A. Head with supraorbital bony crests (fig. 86, C, D); mid-lateral scales 30 or less....6.

B. Head without bony crests; mid-lateral scales 30 or more....7.

6A. No scales between orbit and bony crest (fig. 86, C); interorbital region scaleless....*Butis gymnopomus.*

B. Two or three rows of scales between orbit and bony crest (fig. 86, D); interorbital scaled....*Butis butis.*

[1] See general notes under Gobiidae (p. 176).

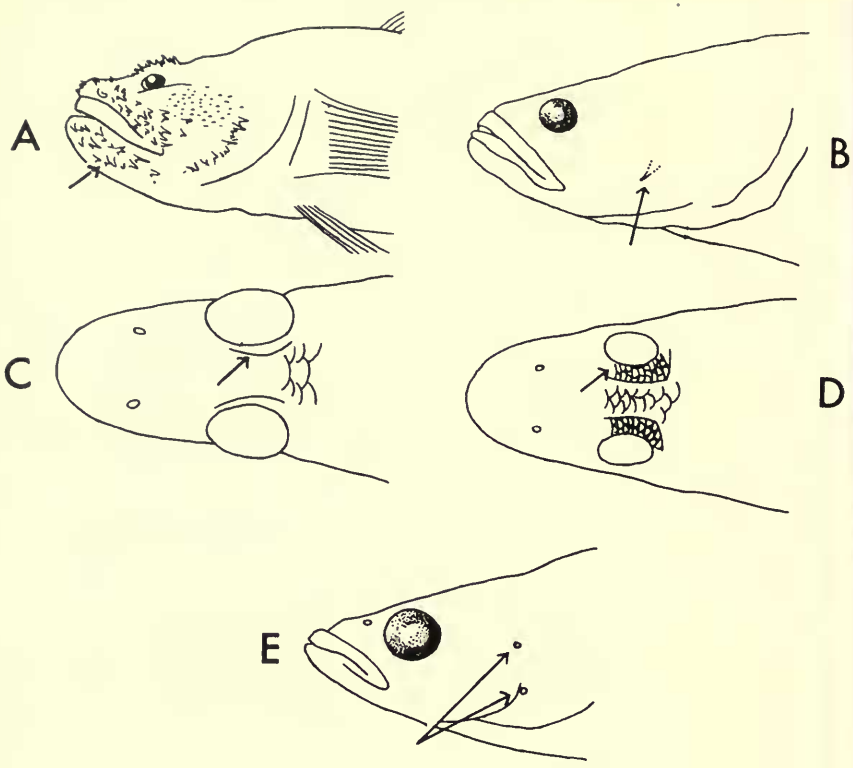

FIG. 86. Key to species of Eleotridae.

7A. Mid-lateral scales less than 45 ..... 8.
B. Mid-lateral scales more than 60 ..... 9.
8A. Mid-lateral scales less than 35; at most two pores along posterior border of preopercle (fig. 86, E) ..... *Ophiocara aporos.*
B. Mid-lateral scales more than 35; three or more pores along posterior border of preopercle ..... *Ophiocara porocephala.*
9A. A black spot on upper caudal base ..... *Oxyeleotris urophthalmus.*
B. No black spot on caudal base ..... *Oxyeleotris marmorata.*

Prionobutis dasyrhynchus (Günther). Figure 87.

Eleotris dasyrhynchus Günther, 1868, Ann. Mag. Nat. Hist., (4), **1**: 265, pl. 12, fig. B—Sarawak.

Prionobutis dasyrhynchus Bleeker, 1877, Versl. Meded. Akad. Wetens. Amsterdam, **12**: 75; Koumans, 1953, Fishes Indo-Austr. Arch., **10**: 314.

Dorsal VI—I,7; pectoral i,17; ventral i,5; anal I,7; mid-lateral scales 25–26; transverse scales at anal origin 9–10; predorsals 10;

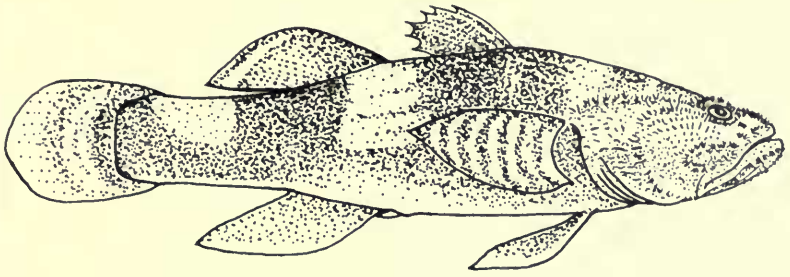

FIG. 87. *Prionobutis dasyrhynchus.*

head 0.344–0.384 (median 0.364; N=3); depth 0.234–0.245 (N=2); eye 0.025–0.036 (median 0.032; N=3); standard length 33.0–58.0 mm.; total length 41.9–71.4 mm.

Color in alcohol dark brown with three tan blotches dorsally, one before first dorsal fin, one between dorsal fins, and one on caudal peduncle; under side of head yellowish; first dorsal fin black with a narrow terminal whitish band and a still narrower one crossing center of fin; second dorsal similar to first or with alternating, narrow, black and white stripes; anal with a median dusky band; caudal yellowish in basal third, black in central third, and with alternating, narrow black and white bands distally; pectoral with alternating, narrow, black and white bands.

The North Bornean specimens have fewer mid-lateral and predorsal scales than Sarawak fishes (30 and 12, respectively, according to Koumans, 1953). The eye is smaller in North Bornean fishes (10–13 times in head) than in Sarawak fishes (8, according to Koumans).

Our sample was caught in turbid fresh water of a small, silt-bottomed forest stream.

Locality.—Tawau District, Kalabakan, Sungei Marikut (3).

Eleotris melanosoma Bleeker. Figure 88.

Eleotris melanosoma Bleeker, 1852, Nat. Tijds. Ned. Indië, **3**: 705—Wahai, Ceram; Koumans, 1953, Fishes Indo-Austr. Arch., **10**: 297.

Dorsal VI—I,7–9 (two of 33 with 7 and two with 9 branched rays); pectoral i,15–18 (mean i,16.7; N=27); ventral I,5; anal I,7–9 (one of 33 with 7 and one with 9 branched rays); mid-lateral scales 46–55 (mean 49.4; N=27); transverse scales at anal origin 14–17 (mean 15.3; N=34); head 0.334–0.372 (median 0.354; N=18); depth

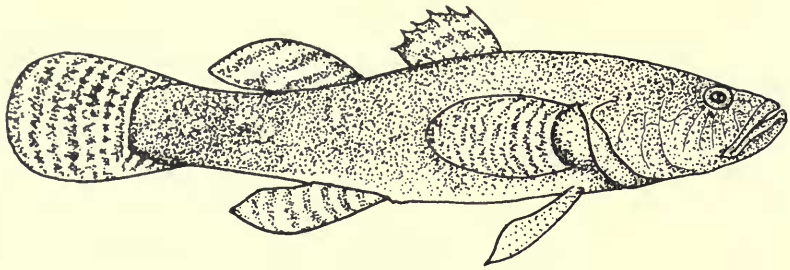

FIG. 88. *Eleotris melanosoma.*

0.203–0.233 (median 0.219; N=13); eye 0.039–0.057 (median 0.050; N=17); standard length 18.5–110.0 mm.; total length 22.7–135 mm.

Color in alcohol dark brown, becoming yellowish brown on belly; obscure, squarish, dark blotches mid-laterally; blotches more conspicuous in small specimens; first dorsal fin with black stripes; other fins with numerous black checks.

Eight gravid females varied in length from 56.4 to 92.0 mm.

This species is abundant in small streams near the coast. Approximately two-thirds of our sample was collected in clear water; 121 were caught over mixed silt and sand bottoms and 148 over sand and gravel.

The food remains in six stomachs consisted of insect fragments (3 stomachs), an 8 mm. crab (1), a 25 mm. prawn (1), an unidentifiable fish (1), and decapod fragments (2).

Localities.—Kinabatangan District, Bilit (7), Deramakot (3), Sungei Gaja (39), tributary of Sungei Kretam Kechil (2); Labuk and Sugut District, Labuk River (2); Sandakan District, Sandakan (1), tributary of Sungei Sapagaya (53), Sepilok Forest Reserve (2); Tawau District, Kalabakan, Sungei Marikut (25), Sungei Tawan (146).

Eleotris fusca (Bloch and Schneider)

Poecilia fusca Bloch and Schneider, 1801, Syst. Ichthy., p. 453—"Orideae insulae rivulis."

Eleotris fusca Günther, 1861, Cat. Fishes Brit. Mus., **3**: 125; Koumans, 1953, Fishes Indo-Austr. Arch., **10**: 294, fig. 74.

Dorsal VI—I,8; pectoral i,16–17 (mean i,16.5; N=8); ventral I,5; anal I,8; mid-lateral scales 48–63 (mean 56.1; N=8); transverse scales at anal origin 16–19 (mean 17.9; N=8); head 0.339–0.405 (median 0.356; N=8); depth 0.205–0.229 (median 0.223; N=3); eye

0.057–0.069 (median 0.059; N=7); standard length 41.0–83.5 mm.; total length 55.6–99 mm.

Color in alcohol dark brown; a black spot at upper corner of base of pectoral fin; an obscure dark longitudinal band sometimes present on body; first dorsal fin with two or three black stripes; other fins with numerous black checks.

All specimens were collected in clear water in small streams (ca. 1 to 2 meters wide) over silt or sand bottoms. The only fish with food in its stomach held a 30 mm. prawn.

Localities.—Kinabatangan District, Sungei Gaja (1); Sandakan District, Sandakan (2); Tawau District, Kalabakan, Sungei Tawan (5).

Bostrichthys sinensis (Lacépède). Figure 89.

Bostrychus sinensis Lacépède, 1802, Hist. Nat. Poissons, **3**: 141, pl. 14, fig. 2—China.

Bostrichthys sinensis Gill, 1860, Proc. Acad. Nat. Sci. Philadelphia, **1860**: 125; Koumans, 1953, Fishes Indo-Austr. Arch., **10**: 286.

Dorsal VI—I,10–11; pectoral i,15–16; ventral i,5; anal I,8–9; head 0.280–0.313 (median 0.304; N=5); depth 0.216–0.231 (N=2); standard length 100.5–147 mm.; total length 122–176 mm.

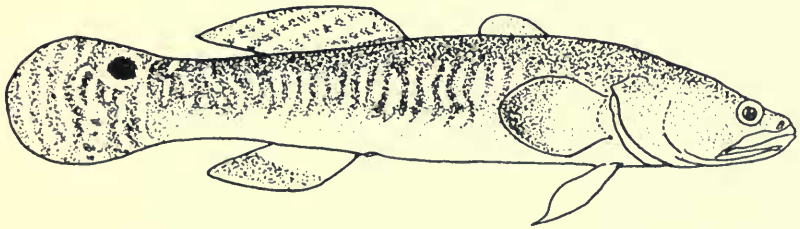

FIG. 89. *Bostrichthys sinensis.*

Color in alcohol dark brown; a large black spot in upper corner of base of caudal fin; caudal and second dorsal fins with narrow black bands; anal, pectoral, and first dorsal dusky, pectoral and anal black near tips.

One female (188 mm.) contained ripe ova.

This species has not yet been collected in fresh water in North Borneo. The fish ponds from which these specimens came are occasionally flooded by spring tides.

Locality.—Sandakan District, Mile 2, Labuk Road, Sandakan (5).

Butis gymnopomus (Bleeker). Figure 90.

Eleotris gymnopomus Bleeker, 1853, Nat. Tijds. Ned. Indië, **4**: 274—Sumatra.

Butis gymnopomus Bleeker, 1856, op. cit., **12**: 215; Koumans, 1953, Fishes Indo-Austr. Arch., **10**: 311.

Dorsal VI—I,8–9 (mean branched rays 8.1; N=15); pectoral i,16–17 (mean i,16.8; N=15); ventral i,5; anal I,7–8 (mean I,7.9;

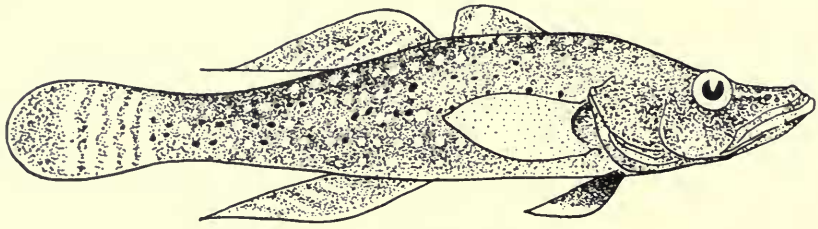

FIG. 90. *Butis gymnopomus.*

N=15); mid-lateral scales 27–29 (mean 28.2; N=15); head 0.352–0.394 (median 0.369; N=15); depth 0.175–0.215 (median 0.196; N=15); standard length 16.5–86.5 mm.; total length 20.9–111.1 mm.

In alcohol color of body and head dark brown; most of lateral scales with a light spot; dark vertical bands visible in young; ventral surface of head lighter in females; first dorsal fin with black triangle bounded posteriorly by line from tip of second spine to base of fifth; second dorsal of males black at base and along last two rays, rest of fin dusky; second dorsal of females much lighter, with a few dark bars on anterior rays; anal of males black except for tips of first five rays; anal of females less densely black; ventrals of males black except at tips of rays, fins of females with black transverse spot across center; pectoral of both sexes colorless; caudal black with a diagonal light area across upper half.

Sexual dimorphism in *gymnopomus* includes more than the color differences just described. The last two rays of the second dorsal and anal fins are elongated, reaching the caudal, in adult males. In females the tips of these rays are widely separated from the caudal. The lengths of the last dorsal rays of the six largest males (standard length 66–86 mm.) were 0.192–0.233 of the standard length, whereas in the six largest females (59–76 mm.) the range was 0.081–0.122.

The genital papilla is longer in males and tapers posteriorly, resulting in a tear-drop form with three small lobes at the tip. The papilla of the female is elliptical in outline, being abruptly rounded at the end which is set with many lobules.

Our samples were collected in clear (27 specimens) and turbid (14) fresh water in small to moderate-sized (2–10 meters wide) forest streams over silt, sand, and gravel.

The diet consists of aquatic insects, crustaceans, and small fishes (Inger, 1955).

Localities.—Kinabatangan District, Sungei Gaja (27), Sungei Pinang (14); Sandakan District, Mile 5, Labuk Road, Sandakan (4).

Butis butis (Hamilton)

Cheilodipterus butis Hamilton, 1822, Fishes of Ganges, p. 57—Ganges River, India.

Butis butis Bleeker, 1861, Versl. Meded. Akad. Wetens. Amsterdam, **12**: 77; Herre, 1933, Jour. Pan-Pacific Res. Inst., **8**, no. 4, p. 5; Koumans, 1953, Fishes Indo-Austr. Arch., **10**: 306.

Dorsal VI—I,8; pectoral i,18; ventral i,5; anal I,7–8; mid-lateral scales 28–29; head 0.362–0.385; standard length 35.5–79.5 mm.; total length 43–99 mm.

Color in alcohol brown, with 6–8 black, vertical bands; black bars radiating from eye; first dorsal fin black; second dorsal and anal with narrow black bands; pectoral with black spots at base, otherwise yellowish; ventral dusky; caudal blackish.

Both specimens were in slightly brackish turbid water.

Localities.—Kinabatangan District, Sungei Gaja (1); Sandakan District, Sandakan (Herre, 1933), Mile 2, Labuk Road, Sandakan (1).

Ophiocara aporos (Bleeker)

Eleotris aporos Bleeker, 1854, Nat. Tijds. Ned. Indië, **6**: 59—Halmaheira and Ternate.

Ophiocara aporos Bleeker, 1877, Versl. Meded. Akad. Wetens. Amsterdam, **11**: 33; Koumans, 1953, Fishes Indo-Austr. Arch., **10**: 346.

Dorsal VI—I,8; pectoral i,13; ventral i,5; anal I,9; mid-lateral scales 30; predorsals 16; transverse scales at anal origin 11; head 0.303; standard length 123 mm.; total length 154 mm.

Color in alcohol brown, with dark mid-lateral streak.

Locality.—Sandakan District, Sandakan (1).

Ophiocara porocephala (Valenciennes). Figure 91.

Eleotris porocephala Valenciennes *in* Cuvier and Valenciennes, 1837, Hist. Nat. Poissons, **12**: 237—Seychelles.

Ophiocara porocephala Bleeker, 1877, Versl. Meded. Akad. Wetens. Amsterdam, **11**: 30; Hardenberg, 1936, Treubia, **15**: 253; Koumans, 1953, Fishes Indo-Austr. Arch., **10**: 343.

Dorsal VI—I,8; pectoral i,13–14 (one out of 6 with i,14); ventral i,5; anal I,7; mid-lateral scales 35–39 (mean 36.8; N=6); predorsals

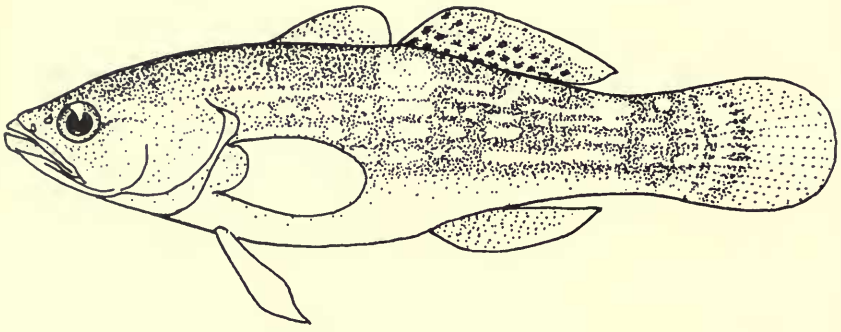

FIG. 91. *Ophiocara porocephala.*

25–27; transverse scales at anal origin 11–14; head 0.338–0.377 (median 0.351; N=6); depth 0.245–0.268 (median 0.261; N=4); standard length 60.4–93.5 mm.; total length 78–115 mm.

Color in alcohol blackish brown; a black horizontal bar behind eye; body with one narrow (on caudal peduncle) and two broad vertical dark bands, each with small light spots; belly light brown; dorsal fins black with longitudinal rows of light spots; margin of second dorsal white; caudal barred with black, the margin white; other fins dusky.

One specimen was caught in a small, clear forest stream having silt and sand bottoms. The others are from fish ponds flooded by spring tides.

Localities.—Kinabatangan District, Sungei Gaja (1); Sandakan District, Mile 2, Labuk Road, Sandakan (5), Tanah Merah (1).

Oxyeleotris urophthalmus (Bleeker)

Eleotris urophthalmus Bleeker, 1851, Nat. Tijds. Ned. Indië, **2**: 202—Bandjermassin, Borneo.

Oxyeleotris urophthalmus Bleeker, 1877, Versl. Meded. Akad. Wetens. Amsterdam, **11**: 23; Hardenberg, 1936, Treubia, **15**: 253; Koumans, 1937, Zool.

Meded. Leiden, **20**: 25; 1953, Fishes Indo-Austr. Arch., **10**: 355; Herre, 1940, Bull. Raffles Mus., no. 16, p. 51.

Dorsal VI—I,8–9; pectoral 16; ventral i,5; anal I,8–9; mid-lateral scales 84; head 0.326–0.330; depth 0.194–0.200; standard length 82.5–123 mm.; total length 102.5–154 mm.

Color in alcohol dark brown with obscure, vertical, black lines on body; a large black spot at upper corner of base of caudal fin; fins brownish, dorsal and caudal with narrow black bands; caudal with a narrow white margin.

One specimen was caught in a small (3 meters wide), clear forest stream having a mixed bottom of silt, sand, and gravel.

Localities.—Kinabatangan District, Sungei Gaja (1); Labuk and Sugut District, Labuk River (1).

Oxyeleotris marmorata (Bleeker). Figure 92.

Eleotris marmorata Bleeker, 1852, Nat. Tijds. Ned. Indië, **3**: 424—Bandjermassin, Borneo.

Oxyeleotris marmorata Bleeker, 1877, Versl. Meded. Akad. Wetens. Amsterdam, **11**: 22; Hardenberg, 1936, Treubia, **15**: 253; Koumans, 1953, Fishes Indo-Austr. Arch., **10**: 354.

Dorsal VI—I,8–9; pectoral i,16–18; ventral i,5; anal I,8; mid-lateral scales 65–73; head 0.358–0.402; depth 0.214–0.227.

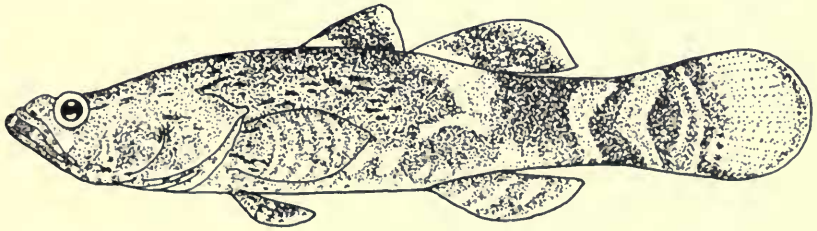

FIG. 92. *Oxyeleotris marmorata.*

Color in alcohol dark brown above, pale brown below; body with a series of large, dark blotches; fins with black bands or dusky.

This species is valued for its flavor and is popular in the markets of towns on the Padas River. It is caught by hook-and-line, cast net, and traps.

Local names.—"Batutu" or "Ubi" (Malay).

Localities.—Kinabatangan District, Lamag (1); Lahad Datu District, Segama River (1); Tenom District, Sapong Estate (2).

GOBIIDAE

The gobies (together with the related eleotrids) are one of several groups of marine fishes that occasionally invade fresh water. These invasions become significant in those areas deficient in ostariophysine fishes. In the Philippine Islands, for example, there are almost no Ostariophysi, and the ecological vacuum left by their absence is filled largely by gobies and eleotrids. Thus these normally marine fishes tend to balance the reduction in the ostariophysine fauna. As a consequence, they have been termed, very appropriately, complementary fresh-water fishes by Myers (1949). In North Borneo the gobies and eleotrids, though not as numerous as in the Philippines, exhibit the same tendency (Inger, 1955).

In addition to the forms listed below, many gobies that live in brackish water are known to enter fresh water in the Indo-Malayan region, although they have not as yet been taken from such situations in North Borneo. At least some of these species probably will be obtained sooner or later in fresh water, in which case the key presented here will be unsatisfactory. This same defect applies to the key to the Eleotridae.

Two specimens of *Stigmatogobius* were not identifiable. Available material is insufficient to permit the description of them as new. They are not included in the key, but the color notes accompanying the species accounts should aid in distinguishing them from the named forms.

Key to Species of Fresh-Water Gobies from North Borneo

1A. Pectoral fin with long fleshy base (fig. 93, A), usually with an angular bend. *Periophthalmodon tredecemradiatus borneensis.*

B. Pectoral fin with at most a short fleshy base (fig. 93, B) ..... 2.

2A. Body with at least two complete black rings; usually two additional bands, complete or not ..... 3.

B. Body without black rings ..... 6.

3A. Caudal fin pointed, longer than head (fig. 93, C) .. *Stenogobius gymnopomus.*

B. Caudal fin rounded, shorter than head (fig. 93, D) ..... 4.

4A. Two complete black rings entirely behind anal base (fig. 93, E). *Brachygobius kabiliensis.*

B. One complete black band entirely behind anal (fig. 93, F) ..... 5.

5A. Black band covering basal two-thirds of pectoral fin; all rays of first dorsal black ..... *Brachygobius doriae.*

B. Black band covering less than half of pectoral; last one or two rays of first dorsal not black ..... *Brachygobius sabanus.*

6A. Snout 1½ or more times length of eye diameter (fig. 93, G) ..... 7.

B. Snout equal to or shorter than eye diameter (fig. 93, H) ..... 9.

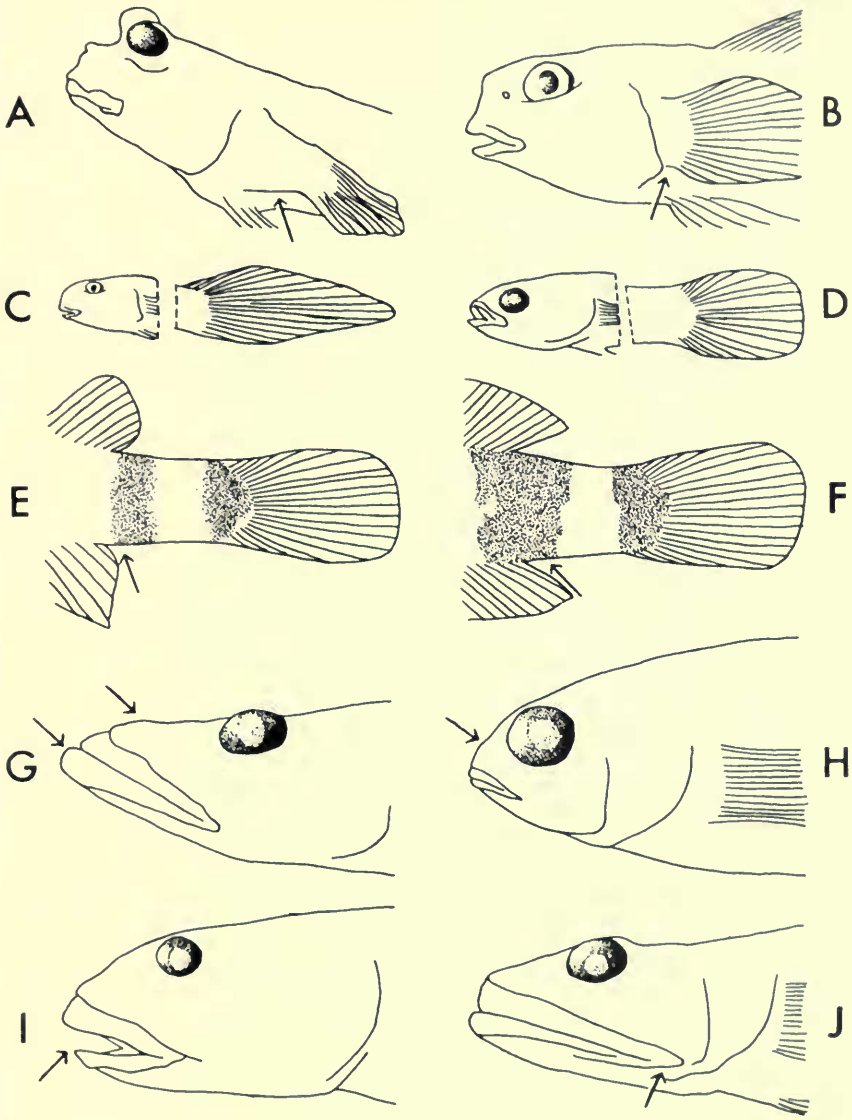

FIG. 93. Key to species of Gobiidae.

7A. Upper jaw projecting beyond the lower (fig. 93, I) ..... *Awaous stamineus.*
B. Lower jaw projecting beyond the upper (fig. 93, G) ..... 8.
8A. Predorsal scales less than 20, usually less than 17 ..... *Glossogobius celebius.*
B. Predorsal scales more than 20, usually 25 or more ..... *Glossogobius giuris.*

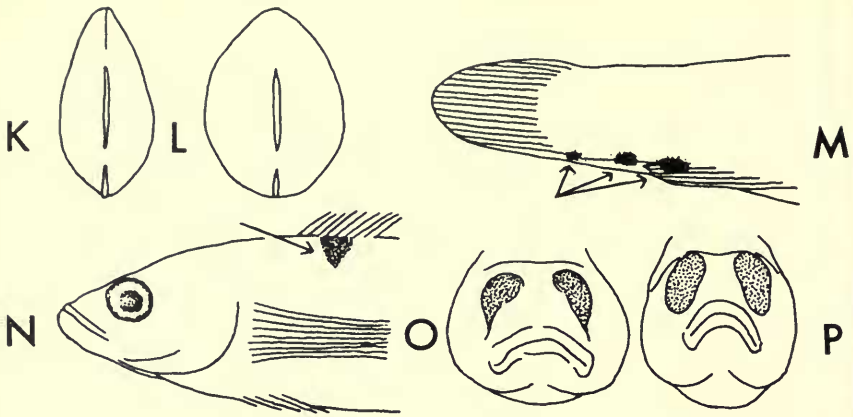

FIG. 93 (*continued*). Key to species of Gobiidae.

9A. Jaws extending behind eye (fig. 93, J).....*Stigmatogobius oligactis.*
B. Jaws not extending behind eye (fig. 93, H).....10.
10A. Body strongly compressed (fig. 93, K).....11.
B. Body slightly compressed or cylindrical (fig. 93, L).....12.
11A. Squarish black spots in mid-ventral line behind anal base (fig. 93, M). *Redigobius bikolanus.*
B. No black spot in mid-ventral line behind anal base..*Redigobius chrysosoma.*
12A. A black saddle across back opposite first dorsal fin (fig. 93, N). *Stigmatogobius sadanundio.*
B. No black saddle.....13.
13A. Head depressed (fig. 93, O).....*Stigmatogobius isognathus.*
B. Head cylindrical (fig. 93, P).....14.
14A. Lower jaw projecting beyond the upper.....*Stigmatogobius römeri.*
B. Upper jaw projecting beyond the lower.....*Stigmatogobius javanicus.*

Periophthalmodon tredecemradiatus borneensis (Bleeker). Figure 94.

Periophthalmus borneensis Bleeker, 1851, Nat. Tijds. Ned. Indië, **1**: 11—Borneo.

Periophthalmus tredecemradiatus borneensis Eggert, 1935, Zool. Jahrb. (Syst.), **67**: 54.

Periophthalmodon tredecemradiatus borneensis Koumans, 1953, Fishes Indo-Austr. Arch., **10**: 219.

Dorsal V–VII—I,11–12; pectoral 11–14; ventral i,5; anal I,10–11; mid-lateral scales 44–48; head 0.280–0.288; depth 0.187–0.213; eye 0.060–0.082; standard length 63.0–80.3 mm.; total length 77.5–100.0 mm.

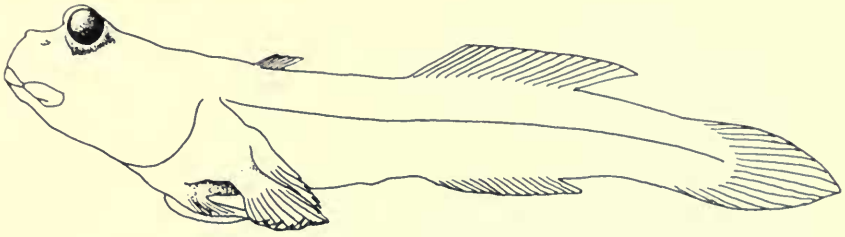

FIG. 94. *Periophthalmodon tredecemradiatus borneensis.*

Color in alcohol grayish above, lighter below; body without conspicuous marking; fins dusky.

Three specimens (75.0–80.3 mm.) contained enlarged ova, the fourth (63.0 mm.) immature ones.

These specimens were caught in the Kalabakan River within the tidal zone but above the reach of saline surface water.

All four stomachs contained parts of terrestrial insects. A small prawn was also found in one stomach.

Local name.—"Belandit."

Locality.—Tawau District, Kalabakan River (4).

Stenogobius gymnopomus (Bleeker). Figure 95.

Gobius gymnopomus Bleeker, 1853, Nat. Tijds. Ned. Indië, **4**: 270—Priaman, Sumatra; Günther, 1861, Cat. Fishes Brit. Mus., **3**: 65.

Stenogobius gymnopomus Koumans, 1941, Mem. Indian Mus., **13**: 216; 1953, Fishes Indo-Austr. Arch., **10**: 34.

Dorsal VI—I,10 (N=12); pectoral 15–17 (mean 16; N=12); anal I,9–10 (only one out of 12 specimens had 9 branched rays); midlateral scales 47–51 (mean 49.1; N=12); transverse scales between origins of second dorsal and anal 11–13 (mean 11.9; N=12); pre-

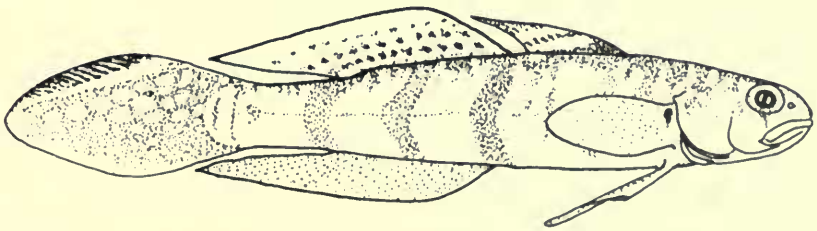

FIG. 95. *Stenogobius gymnopomus.*

dorsal scales 13–20 (mean 16.6; N=12); gill rakers absent or rudimentary; head 0.245–0.277 (median 0.266; N=12); depth 0.174–0.230 (median 0.213; N=12); snout 0.053–0.076 (median 0.062; N=12); eye 0.061–0.079 (median 0.072; N=12); interorbital 0.052–0.071 (median 0.065; N=12); standard length 36.2–78.0 mm.; total length 45.0–113.7 mm.

Color in alcohol pale yellowish, with three to six narrow, vertical, dark bars; first dorsal fin with three narrow, horizontal, black lines; second dorsal with similar though fainter pattern; both dorsals with scattered melanophores; caudal rays checked with black; anal fin usually dusky; pectoral base with a small black spot at upper corner; remainder of pectoral and ventral fins colorless.

Two females (55.5–62.5 mm.) had enlarged ova. The anal fin of males is usually darker than that of females.

This species is more abundant in the short coastal streams than in the interior drainages; 24 were collected in clear water and 26 in turbid water.

The gut, packed with mud and fine sand grains, is kinked but not convoluted as in some detritus feeders (e.g., *Osteochilus*). The digestive tract measured 55 mm. in a fish 50 mm. long. Animals dominated the organic remains in smears from two stomachs. Larvae of Diptera, larval prawns, ostracods, copepods, rotifers, nematodes, protozoans, and plant fragments were found.

Localities.—Kinabatangan District, one mile above mouth of Sungei Tabalin Besar (1); Tawau District, Sungei Brantian (5), Kalabakan, Sungei Maga (2), Sungei Marikut (25), Sungei Tawan (17).

Brachygobius kabiliensis Inger

Brachygobius aggregatus (part) Herre, 1940, Phil. Jour. Sci., **72**: 362.

Brachygobius kabiliensis Inger, 1958, Fieldiana: Zool., **39**: 110, fig. 19—Kabili River, North Borneo.

Dorsal VI—I,6; pectoral 12–14 (mean 13.4; N=8); ventral I,5; anal I,6–7 (only one with I,7; N=8); mid-lateral scales 22–23 (mean 22.6; N=8); predorsal scales 7–8; head 0.348–0.362; standard length 11.5–15.5 mm.

Color in life bright yellow with four black bands on body; first band beginning before origin and extending back to base of third ray of first dorsal fin, band not reaching mid-ventral line; second band reaching from end of first dorsal to base of fifth ray of second dorsal, usually not reaching base of anal; third band beginning behind bases

of anal and second dorsal, reaching mid-ventral line; fourth band at base of caudal.

Localities.—Sandakan District, Sungei Kabili (6), Labuk Road, Mile 2, Sandakan (2).

Brachygobius doriae (Günther)

Gobius doriae Günther, 1868, Ann. Mag. Nat. Hist. (4), **1**: 265, pl. 12, fig. A—Sarawak.

Brachygobius doriae Bleeker, 1874, Arch. Neerl. Sci. Ex. Nat., **9**: 315; Hardenberg, 1936, Treubia, **15**: 252; Inger, 1955, Fieldiana: Zool., **37**: 77; op. cit., **39**: 109.

Brachygobius nunus Koumans, 1953, Fishes Indo-Austr. Arch., **10**: 194 (part).

Dorsal VI—I,7; pectoral 14–17 (mean 16.0; N=12); ventral I,5; anal I,7–8 (only one with I,8; N=12); mid-lateral scales 24–28 (mean 26.3; N=12); predorsal scales 0 (in fishes under 13 mm.) –8; head 0.325–0.395 (median 0.354; N=10); depth 0.257–0.332 (median 0.287; N=10); standard length 11.0–27.0 mm.; maximum total length 32.5 mm.

Color in life yellow with black bands; first black band on body from nape to end of base of first dorsal fin; second black band connecting centers of bases of second dorsal and anal and extending onto caudal peduncle; third band at caudal base; each black band wider than yellow space behind it; black bands continuous on to both dorsals and anal; pectoral and ventral black in basal three-fourths; caudal yellowish.

Our series was obtained in small, clear forest streams just above the tidal zone.

One stomach contained a small fish and one insect fragment.

Localities.—Kinabatangan District, Sungei Gaja (56), tributary of Sungei Kretam Kechil (2).

Brachygobius sabanus Inger

Brachygobius sabanus Inger, 1958, Fieldiana: Zool., **39**: 113, fig. 20—Lamag, Kinabatangan District, North Borneo.

Dorsal VI—I,7–8 (mean of branched rays 7.7; N=15); pectoral 15–16 (mean 15.8; N=14); ventral I,5; anal I,7–8 (mean I,7.7; N=15); mid-lateral scales 24–27 (mean 25.0; N=15); predorsal scales 0–2; head 0.367–0.406 (mean 0.383; N=8); standard length 12.0–26.5 mm.

Color in life black and yellow with three complete black bands on body; first band extending from nape to base of fourth or fifth

ray of first dorsal fin and usually reaching mid-ventral line; second band connecting centers of bases of anal and second dorsal and extending on to caudal peduncle; third band at base of caudal; usually a small triangular dark saddle between each pair of bands.

Localities.—Kinabatangan District, Abai (5), Lamag (20), Mintak (1).

Awaous stamineus (Valenciennes)

Gobius stamineus Valenciennes, 1842, Zool. Voy. Bonite, p. 179, pl. 5, fig. 5—Hawaiian Islands.

Awaous stamineus Koumans, 1941, Mem. Indian Mus., **13:** 252; 1953, Fishes Indo-Austr. Arch., **10:** 153.

Dorsal VI—I,10; pectoral 16; anal I,9; mid-lateral scales 54; transverse scales between origins of second dorsal and anal 14; predorsal scales 20; gill rakers rudimentary, 2+4; head 0.319; depth 0.165; snout 0.099; eye 0.066; interorbital 0.042; standard length 60.5 mm.; total length 76.4 mm.

Color in alcohol pale brown above, yellow below; a row of obscure dark spots along back; a row of eight oblong black spots mid-laterally; both dorsal and caudal with rows of small black spots, those of first dorsal less well defined; anal dusky except near margin; pectoral with a dark spot in upper corner of base; otherwise pectoral and ventral fins colorless.

This specimen was caught in clear, fresh water in a small forest stream.

Locality.—Tawau District, Kalabakan, Sungei Tawan (1).

Glossogobius celebius (Valenciennes)

Gobius celebius Valenciennes *in* Cuvier and Valenciennes, 1837, Hist. Nat. Poissons, **12:** 74—Celebes.

Glossogobius celebius Herre, 1927, Gobies of Philippines, p. 158, pl. 12, fig. 4.

Dorsal VI—I,9; pectoral 18–20; ventral I,5; anal I,8; mid-lateral scales 31; predorsal scales 15–16; transverse scales between origins of second dorsal and anal 9½–10; head 0.314–0.316; depth 0.183; standard length 69.0–75.0 mm.; total length 89–94.5 mm.

Color in alcohol pale brownish with two rows of dark brown markings; a mid-lateral row of 5 or 6 rectangular dark spots; a dorsal row of 3 or 4 triangular blotches alternating with the mid-lateral row; first dorsal fin dusky; second dorsal dusky with a series of blackish squares on the rays; caudal with squarish black spots; anal fin of male black, that of female with light dusting of melanophores; pec-

toral fin dusky; ventral of male with scattered melanophores, that of female colorless.

The genital papilla of the male is oval and tapers gradually to a point. The papilla of the female is oblong and notched at the tip.

Localities.—Jesselton District, 8 miles north of Jesselton (1); Lahad Datu District, Sungei Edam (2).

Glossogobius giuris (Hamilton). Figure 96.

Gobius giuris Hamilton, 1822, Fishes of Ganges, p. 51, pl. 33, fig. 15—Gangetic provinces, India.

Glossogobius giuris Herre, 1927, Gobies of Philippines, p. 162, pl. 27, fig. 1; Koumans, 1935, Zool. Meded. Leiden, **18**: 148; 1953, Fishes Indo-Austr. Arch., **10**: 165 (part); Hardenberg, 1936, Treubia, **15**: 253; Inger, 1955, Fieldiana: Zool., **37**: 78.

Dorsal VI—I,9 (N=11); pectoral 19–21 (mean 20.0; N=11); ventral I,5 (N=7); anal I,8 (N=11); mid-lateral scales 29–31 (mean

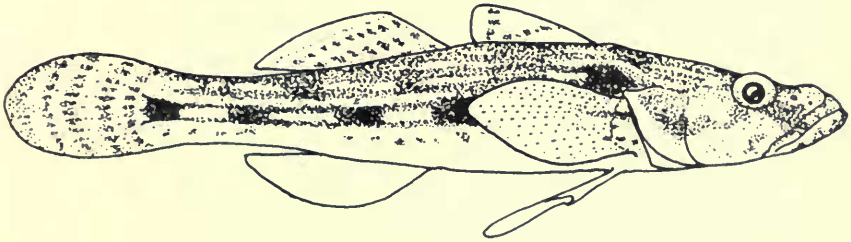

FIG. 96. *Glossogobius giuris.*

30.1; N=11); transverse scales between origins of second dorsal and anal 9–10 (only one with 10; N=11); predorsal scales 22–29 (mean 26.1; N=11); gill rakers 1+7–8; head 0.312–0.375 (median 0.354; N=11); depth 0.157–0.204 (median 0.177; N=11); snout 0.096–0.122 (median 0.105; N=11); eye 0.049–0.085 (median 0.064; N=11); standard length 29.0–145.0 mm.; total length 35.8–180.0 mm.

Color in alcohol sandy brown above, yellowish below; a mid-lateral row of squarish or oblong black spots, the one at the base of the caudal fin darkest; first dorsal dusky, with or without dark squares; second dorsal with 4 or 5 rows of blackish spots; caudal with vertical rows of black spots; other fins colorless.

Of the eight food-containing stomachs, three held fresh-water crabs; three, prawns; one, a specimen of *Eleotris fusca;* and one, fish vertebrae.

Localities.—Kinabatangan District, Sungei Gaja (7); Labuk and Sugut District, Labuk River (1); Sandakan District, tributary of Sungei Sapagaya (1); Tawau District, Kalabakan, Sungei Tawan (4), Sungei Marikut (4).

Redigobius bikolanus (Herre)

Vaimosa bikolana Herre, 1927, Gobies of Philippines, p. 151, pl. 11, fig. 2—Legaspi, Luzon.

Pseudogobius bikolanus Aurich, 1938, Int. Rev. Ges. Hydrobiol., **38**: 161, fig. 19; Inger, 1955, Fieldiana: Zool., **37**: 79.

Redigobius chrysosoma Koumans, 1953, Fishes Indo-Austr. Arch., **10**: 105 (part).

Dorsal VI—I,6; pectoral 16–17; ventral I,5; anal I,6; mid-lateral scales 24; predorsal scales about 8; head 0.303–0.321; depth 0.201–0.228; standard length 9.5–17.0 mm.; total length 12.5–22.0 mm.

Color in alcohol light brown; head usually with two bars from eye to jaw; a preopercular and an opercular spot; four faint bands across back; base of anal fin with two black spots; two similar mid-ventral spots on caudal peduncle; caudal base with two vertical black bars; first dorsal fin with dusky area near base anteriorly and a large black spot between fourth and sixth spines; second dorsal with two longitudinal black stripes.

The body proportions given above differ slightly from those cited by Aurich (1938), who found the head to be 0.33 and the depth 0.27. The four mid-ventral black spots are diagnostic of *bikolanus*.

Specimens were collected in both fresh and brackish water in small streams.

Locality.—Kinabatangan District, Sungei Gaja (8).

Redigobius chrysosoma (Bleeker). Figure 97.

Lophogobius chrysosoma Bleeker, 1875, Arch. Neerl. Sci. Ex. Nat., **10**: 114—Bandjermassin, Borneo.

Redigobius chrysosoma Koumans, 1953, Fishes Indo-Austr. Arch., **10**: 105 (part).

Dorsal VI—I,6; pectoral 16–17; ventral I,5; anal I,6; mid-lateral scales 24–25; predorsal scales 6; head 0.306–0.330; depth 0.293–0.323; standard length 20.5–29.5 mm.; total length 27.5–38.0 mm.

Color in alcohol pale brown with two obscure dark blotches on side of body; a dark opercular spot; a narrow vertical black bar below center of eye; first dorsal fin with a large black spot between the

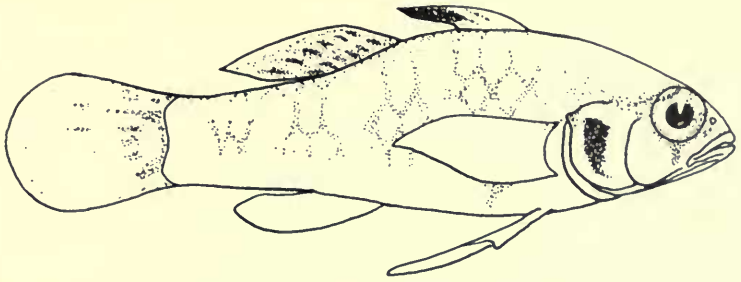

FIG. 97. *Redigobius chrysosoma.*

fourth and sixth rays; second dorsal with two rows of small black spots; caudal base with two superimposed black spots; other fins colorless.

This sample was collected in a small, clear, fresh-water forest stream.

Koumans (1937) gives the head as 0.27 and the predorsal count as 7. He also describes an oblique dark stripe of the opercle that is not present in our fishes.

Locality.—Kinabatangan District, Sungei Gaja (6).

Stigmatogobius oligactis (Bleeker). Figure 98.

Gobiopsis oligactis Bleeker, 1875, Arch. Neerl. Sci. Ex. Nat., **10**: 113—Amboina.

Stigmatogobius oligactis Koumans, 1953, Fishes Indo-Austr. Arch., **10**: 116, fig. 27.

Dorsal VI—I,6; pectoral 16–19 (mean 17.8; N=7); anal i,5–6 (only one out of 7 specimens examined has 5 branched rays); mid-lateral scales 22–27 (mean 24.8; N=7); transverse scales between origins of second dorsal and anal 7; predorsal scales 7–8 (mean 7.7; N=7); gill rakers rudimentary, about 7 on the lower arch;

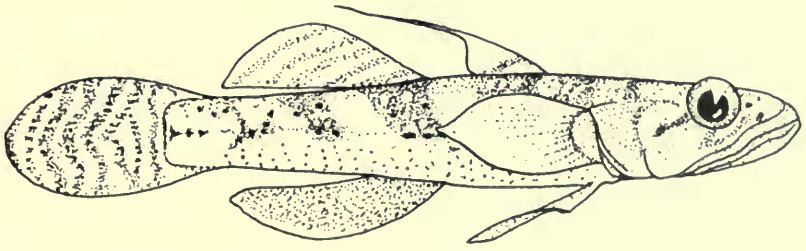

FIG. 98. *Stigmatogobius oligactis.*

head 0.305–0.349 (median 0.324; N=7); depth 0.157–0.185 (median 0.178; N=7); snout 0.075–0.097 (median 0.083; N=7); eye 0.070–0.089 (median 0.074; N=7); interorbital 0.035–0.047 (median 0.040; N=7); standard length 30.8–40.4 mm.; total length 39.0–52.0 mm.

Color in alcohol pale brownish with 4 or 5 indistinct darker blotches on body; fins dusky; dorsals and caudal with rows of black spots.

One specimen was collected in turbid water and seven in clear water of small forest streams.

Localities.—Tawau District, Kalabakan, Sungei Marikut (1), Sungei Tawan (7).

Stigmatogobius sadanundio (Hamilton)

Gobius sadanundio Hamilton, 1822, Fishes of Ganges, p. 52—Calcutta, India.

Stigmatogobius sadanundio Bleeker, 1878, Versl. Meded. Akad. Wetens. Amsterdam, **12**: 201; Koumans, 1953, Fishes Indo-Austr. Arch., **10**: 111, figs. 24 and 25.

Dorsal VI—I,7; pectoral 17–18; ventral I,5; anal I,8; mid-lateral scales 27; predorsal scales 9; head 0.312–0.338; depth 0.267–0.268; standard length 14.0–21.0 mm.; total length 17.5–27.0 mm.

Our specimens apparently differ from *sadanundio* Hamilton in coloration of the dorsal. In the present series, a black area begins high on the body and extends on to the first dorsal, covering that fin from the first spine to the fifth and from the base to the tips of the fourth and fifth. When the fin is depressed, the fish appears to have a black saddle. The black area does not extend onto the sides in all Thai specimens (Smith, 1933). In *sadanundio* the black is restricted to the space between the fourth and sixth dorsal spines.

Locality.—Sandakan District, Tanah Merah, Sandakan (4).

Stigmatogobius isognathus Bleeker

Stigmatogobius isognathus Bleeker, 1878, Versl. Meded. Akad. Wetens. Amsterdam, **12**: 203—Singapore; Koumans, 1932, Zool. Meded. Leiden, **15**: 6; 1953, Fishes Indo-Austr. Arch., **10**: 115.

Dorsal VI—I,6–7 (only one out of 9 with 7 branched rays); pectoral 16–18 (mean 17.1; N=9); anal I,6; mid-lateral scales 23–26 (mean 25.1; N=9); transverse scales between origins of second dorsal and anal 7; predorsal scales 6–7 (mean 6.5; N=9); circumpeduncular scales 12; gill rakers 2–3+6–8, total 8–10 (mean total 9.4; N=7); head 0.281–0.341 (median 0.303; N=9); depth 0.182–0.216 (median

0.190; N=9); snout 0.069–0.080 (median 0.072; N=6); eye 0.081–0.089 (median 0.084; N=6); interorbital 0.029–0.043 (median 0.036; N=6); standard length 22.0–32.9 mm.; total length 27.0–40.8 mm.

Color in alcohol light brown; two alternating rows of obscure black spots on side; head peppered with fine black dots, an oblique dark bar running downward from behind eye; first dorsal fin with conspicuous black spot between fourth and sixth spines; second dorsal and caudal barred with black; other fins colorless.

According to Koumans (1953) the head of *isognathus* is smaller (0.250) than in our specimens and the pattern is lacking. The difference in pigmentation may be due to the effects of long preservation, since Koumans was describing fishes collected by Bleeker.

Females with enlarged ova measured 27.4–32.9 mm.

Two fishes were collected in turbid water and 20 in clear water of small forest streams having bottoms of silt, sand, and gravel.

Localities.—Sandakan District, tributary of Sungei Sapagaya (2); Tawau District, Kalabakan, Sungei Tawan (13), Sungei Maga (7).

Stigmatogobius römeri (Weber)

Gobius römeri Weber, 1911, Abh. Senck. Naturf. Ges., **34**: 39, fig. 8—Aru Island.

Stigmatogobius römeri Koumans, 1953, Fishes Indo-Austr. Arch., **10**: 113, fig. 26.

Dorsal VI—I, 6; pectoral 16–17; ventral I,5; anal I,6; mid-lateral scales 23–24; predorsal scales 7; head 0.387–0.389; standard length 21.5–23.0 mm.; total length 27.0–28.5 mm.

Color in alcohol light brown, dusted with fine black dots; irregular dark areas on preopercle and opercle; both dorsal fins with two longitudinal dark stripes, the lower one of the first dorsal more intense posteriorly; caudal with faint dark bars; other fins unmarked.

Locality.—Kinabatangan District, Bilit (2).

Stigmatogobius javanicus (Bleeker)

Gobius javanicus Bleeker, 1856, Nat. Tijds. Ned. Indië, **11**: 88—Patjitan, Java.

Stigmatogobius javanicus Koumans, 1932, Zool. Meded. Leiden, **15**: 11; 1953, Fishes Indo-Austr. Arch., **10**: 122.

Dorsal VI—I,7; pectoral 16–17; anal I,6; mid-lateral scales 25–27; transverse scales between origins of second dorsal and anal 7; predorsal scales 6–7; circumpeduncular scales 12; gill rakers 2+6–7; head 0.277–0.286; depth of body 0.208–0.221; snout 0.053–0.066;

eye 0.083–0.090; interorbital 0.028–0.034; standard length 24.9–26.2 mm.; total length 31.4–32.3 mm.

Color in alcohol pale brownish with obscure dark markings in upper half of body; a black bar from eye to mouth, a second vertical bar below eye; first dorsal fin with an intense black spot between fourth and sixth spines; second dorsal and caudal barred with black; other fins colorless.

Our fishes, all of which are females containing enlarged ova, were caught in clear water in a small forest stream.

Locality.—Tawau District, Kalabakan, Sungei Tawan (4).

Stigmatogobius sp. A

Dorsal VI—I,6; pectoral 17; ventral I,5; anal I,6; mid-lateral scales 24; predorsal scales 8; head 0.352; depth 0.236; standard length 16.5 mm.; total length 20.5 mm.

Preopercle naked; opercle with three large scales; three longitudinal rows of sensory papillae across suborbital, one longitudinal series across preopercle.

Color in alcohol brown with four broad, dark brown, oblique bands in upper half of trunk; both dorsals with two black longitudinal stripes; caudal with dark crossbars; a transverse black bar across base of pectoral.

Locality.—Kinabatangan District, Sungei Pinang (1).

Stigmatogobius sp. B

Dorsal VI—I,6; pectoral 17; ventral I,5; anal I,6; mid-lateral scales 28; predorsal scales 11; head 0.308; depth 0.164; standard length 14.5 mm.; total length 19.0 mm.

Preopercle naked; opercle with about 7 scales; one longitudinal row of papillae across cheek from gape, one longitudinal row across preopercle.

Color in alcohol light brown, with seven narrow, dark brown, oblique bands on upper half of side, continuous over back; a distinct narrow, dark, horizontal stripe across preopercle from lower border of orbit; first dorsal fin dusky; second dorsal with two longitudinal black stripes; a black submarginal band on anal; caudal with interrupted black crossbars.

Locality.—Kinabatangan District, Sungei Gaja (1).

TAENIOIDIDAE

Taenioides cirratus (Blyth). Figure 99.

Amblyopus cirratus Blyth, 1860, Jour. Asiatic Soc. Bengal, **29**: 147—India.

Taenioides cirratus Koumans, 1941, Mem. Indian Mus., **13**: 301; 1953, Fishes Indo-Austr. Arch., **10**: 270.

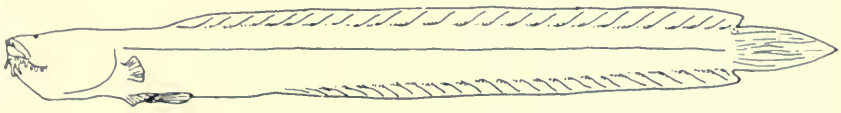

FIG. 99. *Taenioides cirratus.*

Dorsal VI,42–45; pectoral 14–15; anal I,40–45; head 0.137–0.146; depth 0.091; predorsal length 0.229–0.238; preanal length 0.351–0.369; standard length 180–241 mm.; total length 207–270 mm.

Color pinkish in life, grayish white in alcohol.

Three partly digested specimens were found in the stomach of *Johnius semiluctuosus.*

Locality.—Tawau District, Kalabakan River (2).

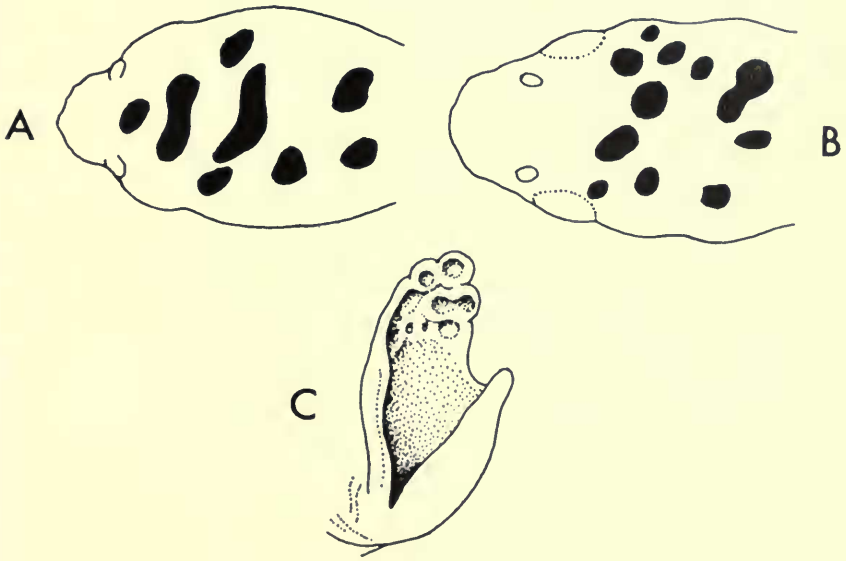

FIG. 100. Key to species of Tetraodontidae.

TETRAODONTIDAE

KEY TO SPECIES FROM NORTH BORNEO

1A. Body without black spots; dorsal fin with 20 or more rays. *Chonerhinus modestus.*

B. Body spotted with black; dorsal with less than 20 rays.....2.

2A. Top of head and back with at least one transverse black bar (fig. 100, A)....3.

B. Top of head and back with round spots (fig. 100, B)..... *Tetraodon leiurus.*

3A. Inner surfaces of bifid nasal tentacles spongy in all fishes 40 mm. or more in length (fig. 100, C); ventrolaterally without a broad blackish band. *Tetraodon fluviatilis.*

B. Inner surfaces of bifid nasal tentacles smooth; ventrolaterally with a broad blackish band..... *Tetraodon kretamensis.*

The spotted puffers (*Tetraodon*) are referred to as "Buntal" (Malay).

Chonerhinus modestus (Bleeker). Figure 101.

Tetraodon (Arothron) modestus Bleeker, 1851, Nat. Tijds. Ned. Indië, **1**: 16—Bandjermassin, Borneo.

Chonerhinos modestus Bleeker, 1860, Act. Soc. Sci. Indo-Neerl., **8**: 65.

Chonerhinus modestus Herre, 1940, Bull. Raffles Mus., no. 16, p. 55.

Dorsal ii–vii,17–24, total 22–26 (mean total 23.8; N=16); pectoral ii,12–14 (mean ii,13.1; N=16); anal i–iii,15–19, total 17–21 (mean total 19.8; N=16); head 0.293–0.349(median 0.316; N=16); depth 0.279–0.328 (median 0.316; N=15); snout 0.057–0.102 (median 0.096; N=15); eye 0.090–0.123 (median 0.100; N=15); interorbital 0.130–0.180 (median 0.164; N=15); standard length 30.8–57.5 mm.; total length 38.0–68.5 mm.

Color olive above, silvery below; body and fins without markings.

One female (54.6 mm.) contained enlarged ova.

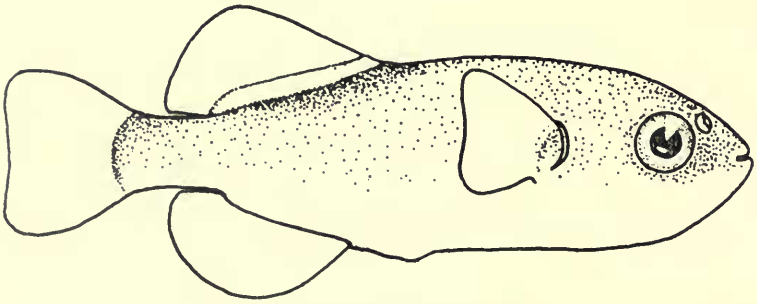

FIG. 101. *Chonerhinus modestus.*

All of our specimens were collected in large, turbid rivers. This species penetrates farther into the interior of Borneo than do the species of *Tetraodon*.

Of 11 food-containing stomachs, 6 held bits of leaves; 6, parts of terrestrial insects; 3, Plecoptera nymphs; 1, Trichoptera larval cases; 3, unidentifiable insect larvae; 2, Acarina; and 2, parts of fishes. Each piece of leaf had been snipped off by the sharp teeth into a curved shape.

Localities.—Kinabatangan District, Kinabatangan River at Deramakot (3), below mouth of Sungei Malubok (62), mouth of Sungei Deramakot (10), Lamag (1); Sandakan District, Sungei Segaliud and Sungei Sibuga (Herre, 1940b).

Herre (op. cit.) recorded the locality "Sibugal River," which we take to be the Sibuga, as the former name does not appear on available maps or gazetteers.

Tetraodon leiurus Bleeker. Figure 102.

Tetraodon leiurus Bleeker, 1852, Verh. Batavia Gen., **24**, (Blootk.), p. 18—Batavia, Java.

Dorsal ii–iii,9–11, total 12–13 (mean total 12.5; N=4); pectoral ii,18 (N=4); anal ii,9 (N=4); head 0.374–0.401 (median 0.381; N=4); depth 0.327–0.423 (median 0.372; N=4); snout 0.103–0.125 (median 0.116; N=4); eye 0.107–0.133 (median 0.120; N=4); interorbital 0.229–0.248 (median 0.234; N=4); standard length 38.7–59.5 mm.; total length 48.8–72.8 mm.

Color olive green above and on sides, yellow or whitish below; top and sides of head and body with round black spots, each surrounded by a yellow ring; fins without markings.

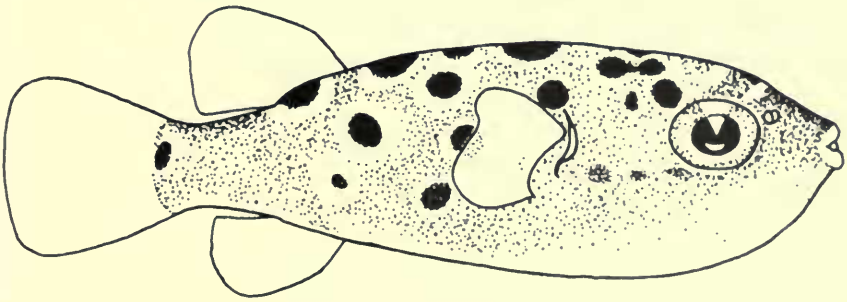

FIG. 102. *Tetraodon leiurus.*

Specimens were caught in the turbid Kalabakan River. Stomachs contained insect fragments.

Locality.—Tawau District, Kalabakan River (2).

Tetraodon fluviatilis Hamilton

Tetrodon fluviatilis Hamilton, 1822, Fishes of Ganges, p. 6, pl. 30, fig. 1—Bengal, India; Hardenberg, 1936, Treubia, **15**: 254; 1937, op. cit., **16**: 13.

Tetraodon fluviatilis Herre, 1933, Jour. Pan-Pacific Res. Inst., **8**, no. 4, p. 5; Inger, 1955, Fieldiana: Zool., **37**: 81.

Dorsal ii–iii,10–12, total 13–15 (mean total 13.8; N=12); pectoral i–ii,19–21; total 21–23 (mean total 21.8; N=12); anal ii,9–10 (mean ii,9.8; N=12); head 0.418–0.496 (median 0.462; N=12); standard length 30.0–105.0 mm.; total length 40.0–138 mm.

Color olive green above and on sides, with rounded or oblong black spots; usually transverse interorbital and occipital black bars; below yellow or whitish; caudal with two or more black crossbars; other fins unmarked.

All specimens were collected in medium-sized (5–8 meters) to large streams in turbid water. This species occurs in brackish as well as fresh water. The counts and measurements include nine fishes from brackish water downstream from the place at which the three listed below were caught.

Fragments of mollusk shells and small fishes were found in two stomachs.

Localities.—Kinabatangan District, Sungei Pinang (3).

Tetraodon kretamensis Inger

Tetraodon kretamensis Inger, 1953, Fieldiana: Zool., **34**: 149, fig. 27—Pinang River, Kinabatangan District, North Borneo; 1955, op. cit., **37**: 81.

Dorsal ii–iii,8–11, total 10–13 (mean total 11.7; N=24); pectoral ii,15–18 (mean ii,16.5; N=24); anal i–ii,7–9, total 9–11 (mean total 10.2; N=24); head 0.387–0.475 (median 0.455; N=13); depth 0.350–0.414 (median 0.382; N=5); snout 0.126–0.150 (median 0.133; N=5); eye 0.123–0.147 (median 0.137; N=5); interorbital 0.210–0.226 (median 0.214; N=5); standard length 11.6–52.0 mm.; total length 15.5–64.0 mm.

Color olive green above and on sides, with rounded and oblong black spots; usually a transverse interorbital occipital black bar; a broad blackish band ventrolaterally, especially strong in posterior half of body; ventrally yellow or whitish; caudal fin unmarked or with faint dusky spots; other fins unmarked.

Though more abundant in brackish water, this species invades the lower reaches of small fresh-water streams. It lives in both turbid and clear water.

Eleven food-containing stomachs were examined. Three contained Plecoptera nymphs; 3, fragments of decapod crustaceans; 2, unidentifiable insect fragments; 1, an isopod; 1, three Trichoptera larvae; 1, fragments of a lepidopterous larva; and 2, pieces of vascular plants. In all, 6 contained aquatic animals; 3, terrestrial animals; and 2, plant fragments.

Localities.—Kinabatangan District, Sungei Gaja (12), Sungei Pinang (35).

ECOLOGY

Introduction

Most of our ecological information was obtained at three field bases in eastern North Borneo: Bukit Kretam and Deramakot, Kinabatangan District, and Kalabakan, Tawau District. Additional observations were made during brief stays at Sapagaya Forest Reserve and Sepilok Forest Reserve in Sandakan District. All five bases lie in lowland rain forest. We have supplemented our information with observations made in the Baleh River basin of central Sarawak.

Besides the specimens in the station lists given below, fishes were caught at each base by incidental collecting activity. Cast nets, hook-and-line, and trammel nets were used.

Descriptions of field bases.—Characteristics of the collecting stations at Bukit Kretam, summarized in Table 20, have already been described in detail (Inger, 1955). Figure 2 is an aerial view of the forest at Bukit Kretam.

The Deramakot base, 300 river kilometers from the mouth of the Kinabatangan River and within 100 meters of sea level, lies within the flat portion of the Kinabatangan basin. At median water level the banks of the river are about 15 meters high. The forest on the flat land back from the river was rich in vines and undergrowth and much plant debris lay on the forest floor. The canopy was more or less continuous. The soil was usually damp and had a clayey texture. Scattered through the flat area were small, low ridges (ca. 15 to 40 meters above the surrounding lowlands). The small streams in the flat, alluvial area were perpetually turbid,

had deep banks, and muddy to sandy bottoms. Downstream from the Sungei Deramakot, a minor tributary of the Kinabatangan, are several hills, the highest of which rises 200–250 meters above the river. The soil on these hills was drier and sandier and had less plant debris than that of the flat lands, and undergrowth was much sparser. Streams draining these hills had clear water (except after heavy rains), sandy to rocky bottoms, and irregular banks. These streams resembled those in the Kalabakan area (cf. figs. 106 and 109). Dates of our stay at Deramakot were April 22–May 18, 1956.

Deramakot Stations (fig. 103):

Station 2.—Mouth of Sungei Deramakot. April 26, 1956. Shore vegetation old secondary growth; trees, vines, herbs, and grasses

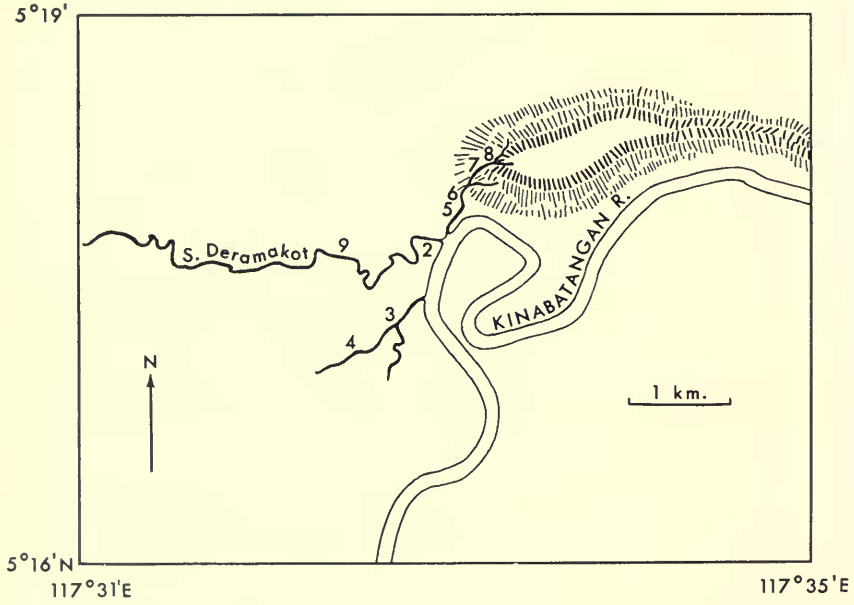

Fig. 103. Map of Deramakot base, Kinabatangan District, North Borneo.

at edge of bank. No submerged or emergent vascular plants. Banks steep, mud, 3 meters high. Bottom mud. Maximum width 20 meters; maximum depth 3 meters. No riffles, depth rather uniform. Water yellowish brown, turbid; Secchi disk disappeared at 45 cm. Current 210 meters/hr. Previous rainfall: 9 mm. on April 24; 2.5 mm. on April 25. Kinabatangan River in minor flood. Sky clear. Shade

33 per cent at 15:00 hours. Surface temperature 32° C. Air temperature in shade 31° C. Rotenone.

A second collection made on May 9, 1956. Depth and width the same. Secchi disk disappeared at 82 cm. Rainfall less than 2 mm. on two preceding days. Kinabatangan River in minor flood. Sky overcast. Time 07:00–13:00 hours. Surface temperature 27.5° C. (08:00 hrs.); air temperature 27.5° C. Rotenone.

FAUNA

Setipinna melanochir (5)
Rasbora myersi (4)
Luciosoma pellegrini (2)
Puntius bulu (23)
Cyclocheilichthys repasson (17)
Dangila sabana (1)
Osteochilus microcephalus (1)
Lobocheilus bo (1)
Nemachilus olivaceus (1)
Ompok sabanus (2)
Mystus nemurus (13)
Batrachocephalus mino (5)
Toxotes chatareus (1)
Osphronemus goramy (4)
Chonerhinus modestus (10)

Station 9.—Sungei Deramakot, several kilometers upstream from Sta. 2. May 5, 1956. Shore vegetation logged primary dipterocarp forest; trees and vines to stream edge. No submerged or emergent vascular plants. Banks steep, 2 meters high. Bottom mud. Maximum width 10 meters; maximum depth 2.9 meters. No riffles; one long pool (100 meters). Water yellowish brown, turbid as Sta. 2. Current not measured. Previous rainfall: 51 mm. on May 3; none on May 4. Kinabatangan River in minor flood. Sky clear. Shade nil. Time 08:00–12:00. Rotenone.

FAUNA

Rasbora sp. (5)
Puntius bulu (3)
Garra borneensis (2)
Mystus nemurus (13)
Mastacembelus keithi (4)
Toxotes chatareus (1)
Lutianus argentimaculatus (1)

Station 3.—Unnamed stream in flat lowlands (fig. 104). April 28, 1956. Shore vegetation primary dipterocarp forest; trees, vines, and herbs to banks. Dead branches but no living submerged or emergent vascular plants. Banks steep; 1–2 meters high. Bottom mud with plant fragments. Maximum width 3.5 meters; maximum depth 1.1 meters. No riffles; one pool 11 meters long. Water brown, turbid; Secchi disk disappeared at 47 cm. Current almost nil. Previous rainfall: a trace on April 26; 4.6 mm. on April 27. Sky clear to partly cloudy. Shade 90 per cent at 13:30 hours. Time 13:30–15:30. Surface temperature 27°, air 30° C. Rotenone.

FIG. 104. Station 3 in flat lowlands at Deramakot, North Borneo.

FAUNA

Nematabramis everetti (88)
Leptobarbus melanotaenia (4)
Puntius sealei (26)
P. binotatus (6)
Hampala macrolepidota (1)
Cyclocheilichthys repasson (15)
Osteochilus microcephalus (31)
Nemachilus olivaceus (4)
Acanthophthalmus mariae (2)
Acanthopsis choirorhynchus (4)
Ompok sabanus (1)
Mystus nemurus (19)
Clarias teysmanni (1)
Dermogenys pusillus (5)
Ophicephalus melanosoma (1)
Nandus nebulosus (7)

Station 4.—Upstream from Sta. 3. April 30, 1956. Shore vegetation primary dipterocarp forest. Roots of trees but no other living submerged or emergent vascular plants. Banks steep; 1–2 meters high. Bottom mud with dead leaves and other plant fragments. Maximum width 1.1 meters; maximum depth 25 cm. No riffles; one pool 6 meters long. Water brownish, turbid; Secchi disk not used. Current 30 meters/hr. Previous rainfall: 1.8 mm. on April 28; none on April 29. Sky clear. Shade 80 per cent. Time 08:00–09:00. Surface temperature 25°, air 28° C. Rotenone.

FAUNA

Rasbora sp. (6)
Puntius sealei (13)
Nemachilus olivaceus (23)
Acanthopsis choirorhynchus (6)
Ompok sabanus (1)
Wallago maculatus (2)
Mystus nemurus (1)
Clarias teysmanni (1)
Dermogenys pusillus (1)
Ophicephalus melanosoma (1)

Station 5.—Unnamed hill stream. May 2, 1956. Shore vegetation primary dipterocarp forest. A few dead branches but no living submerged or emergent vascular plants. Banks steep; 0.6–1.3 meters high. Bottom silt, sand, and rocks. Maximum width 3 meters; maximum depth 60 cm. One pool 6 meters long, followed by 40 meters of riffles and small pools. Water clear, bottom visible. Current 60 meters/hr. Previous rainfall: 7.6 mm. on April 30; none on May 1. Sky partly cloudy. Shade 75 per cent. Time 09:00–14:00. Water temperature not recorded; air 26° C. at 09:00. Rotenone.

FIG. 105. Pool at Station 6, Deramakot, North Borneo.

FIG. 106. Riffles at Station 6, Deramakot, North Borneo.

FAUNA

Anguilla borneensis (13)
Mastacembelus keithi (6)
Nematabramis everetti (46)
Rasbora sumatrana (37)
Luciosoma pellegrini (4)
Leptobarbus melanotaenia (13)
Puntius sealei (56)
P. binotatus (12)
P. bramoides (2)
Hampala macrolepidota (4)
Cyclocheilichthys repasson (12)
Osteochilus microcephalus (113)
Lobocheilus bo (2)
Schismatorhynchus heterorhynchus (1)
Nemachilus olivaceus (5)
Acanthophthalmus mariae (14)
Acanthopsis choirorhynchus (18)
Wallago maculatus (6)
Mystus nemurus (7)
Clarias teysmanni (1)
Ophicephalus melanosoma (1)
Eleotris melanosoma (3)

Station 6.—Upstream from Sta. 5. May 3, 1956. Shore vegetation primary dipterocarp forest. A few dead branches but no living submerged or emergent vascular plants. Banks flat to steep, 0.3–1 meter high. Bottom sand and gravel in pool, with dead leaves; gravel and rock in riffle. Pool (fig. 105), width 3 meters, maximum depth 88 cm., length 7 meters. Riffles (fig. 106) downstream from pool, width 1.5 meters, maximum depth 30 cm., length 20 meters. Water clear, bottom visible. Current 60 meters/hr. in pool, 480 meters/hr. in riffles. Previous rainfall none for two days. Sky partly

cloudy. Shade 25 per cent in pool, 95 per cent in riffle. Time 08:00–12:00. Surface temperature 25° C., air 27° C. at 08:00. Rotenone.

FAUNA

Anguilla borneensis (32)
Mastacembelus keithi (3)
M. armatus (1)
Nematabramis everetti (3)
Rasbora sumatrana (16)
Leptobarbus melanotaenia (2)
Puntius sealei (9)
Hampala macrolepidota (2)
Cyclocheilichthys repasson (5)
Osteochilus microcephalus (35)
Lobocheilus bo (4)
Epalzeorhynchos kalliurus (3)
Gastromyzon borneensis (2)
Homaloptera weberi (1)
Nemachilus olivaceus (11)
Acanthophthalmus mariae (57)
Acanthopsis choirorhynchus (14)
Mystus nemurus (10)

Station 7.—Upstream from Sta. 6. May 3, 1956. Shore vegetation primary dipterocarp forest. Dead branches but no living submerged or emergent vascular plants. Banks with moderate slope. Bottom sand, gravel, and rocks. Maximum width 1.5 meters, maximum depth 75 cm. Length of station 75 meters. Water clear, bottom visible. Current not measured. Previous rainfall: none for two days. Sky partly cloudy. Shade 10–90 per cent. Time 09:00–14:00. Temperatures not recorded. Rotenone.

FAUNA

Anguilla borneensis (34)
Mastacembelus keithi (15)
Nematabramis everetti (95)
Rasbora sumatrana (33)
Luciosoma pellegrini (2)
Leptobarbus melanotaenia (10)
Puntius sealei (35)
Hampala macrolepidota (8)
Cyclocheilichthys repasson (6)
Osteochilus microcephalus (84)
Lobocheilus bo (23)
Schismatorhynchus heterorhynchus (6)
Epalzeorhynchos kalliurus (8)
Garra borneensis (4)
Gastromyzon borneensis (15)
Homaloptera weberi (1)
Nemachilus olivaceus (47)
Acanthophthalmus mariae (42)
Acanthopsis choirorhynchus (15)
Wallago maculatus (2)
Mystus nemurus (25)
Clarias teysmanni (4)
Betta unimaculata (13)

Station 8.—Headwaters of hill stream. May 3, 1956. Shore vegetation primary dipterocarp forest. No submerged or emergent vascular plants. Banks steep, 1–2 meters high. Part of station above low waterfall (fig. 107). Bottom gravel and rock. Maximum width 1 meter; maximum depth 56 cm. Water clear, bottom visible. Current (below waterfall) in pool 180 meters/hr., in riffle 360 meters/hr. Previous rainfall none for two days. Sky partly cloudy. Shade 25–90 per cent. Time 09:00–12:00. Surface temperature 25°, air 26° C. at 09:00. Rotenone.

FIG. 107. Station 8 on hill stream at Deramakot, North Borneo.

FAUNA

Anguilla borneensis (7)
Mastacembelus keithi (2)
Nematabramis everetti (16)
Rasbora sumatrana (6)
Puntius sealei (5)
Hampala macrolepidota (1)
Schismatorhynchus heterorhynchus (1)
Gastromyzon borneensis (4)
Nemachilus olivaceus (4)
Mystus nemurus (3)
Clarias teysmanni (1)

Two *Anguilla* and two *Gastromyzon* were caught above the waterfall.

Station 10.—A gravel bar in mid-stream of Kinabatangan River 8 kilometers upstream from Deramakot. May 8, 1956. Shore vegetation old secondary growth, not overhanging bar. Bar 100 × 50 meters, exposed in middle. No submerged or emergent vascular plants. Bottom silt, sand, and gravel. Maximum depth of capture 1.6 meters. Water turbid. Current strong to moderate. Time 18:30–20:00. Temperatures not recorded. Quarter-inch minnow seine.

FAUNA

Nematabramis everetti (11)
Rasbora myersi (150)
Luciosoma pellegrini (263)
Puntius bramoides (6)
Homaloptera weberi (3)
Nemachilus olivaceus (56)
Acanthopsis choirorhynchus (23)
Acrochordonichthys melanogaster (9)

Cyclocheilichthys repasson (74)
Osteochilus microcephalus (1)
Lobocheilus bo (229)
Schismatorhynchus heterorhynchus (158)
Epalzeorhynchos kalliurus (55)
Garra borneensis (35)
Ompok sabanus (21)
Kryptopterus parvanalis (2)
Mystus nemurus (4)
M. sabanus (8)
Pangasius tubbi (1)
Chonerhinus modestus (62)

One collection was made in the mouth of a small, unnamed tributary of the Kinabatangan River, 30 kilometers downstream from the Sungei Deramakot and 1.5 kilometers upstream from the mouth of the Sungei Tabalin Besar. This site, called "Tabalin" in the ecological tables, had the following characteristics:

April 21, 1956. Shore vegetation, old secondary growth. No submerged or emergent vascular plants. Banks steep; 3 meters high. Bottom mud. Maximum width 8 meters, maximum depth 2 meters. Length of station 10 meters. Water yellowish brown, very turbid. Current not measured, slow. No data on previous rainfall. Sky clear. No shade. Time 16:00–17:00. Temperatures not recorded. Quarter-inch minnow seine.

FAUNA

Corica soborna (1)
Nematabramis everetti (50)
Rasbora myersi (231)
Cyclocheilichthys repasson (44)
Dangila sabana (1)
Osteochilus microcephalus (10)
Lobocheilus bo (23)
Schismatorhynchus heterorhynchus (28)
Epalzeorhynchos kalliurus (34)
Garra borneensis (7)
Nemachilus olivaceus (1)
Ompok sabanus (19)
Mystus nemurus (2)
Stenogobius gymnopomus (1)

The third major base, on the Kalabakan River about 45 kilometers from its mouth, lies in an area of rugged topography. The Kalabakan basin consists of many small hills flanked on the south and west by a high ridge. The entire area had been covered by dipterocarp forest except for a few narrow flat strips of land that had been cleared by natives and then abandoned to secondary growth. Just prior to our work in 1956, intensive logging operations had cleared large tracts of forest. Large patches of virgin forest remained, however, and one of these was drained by the Sungei Tawan (fig. 108), a small tributary of the Kalabakan. The Tawan forest resembles those at Bukit Kretam and Deramakot, having a closed, high canopy and relatively little undergrowth. Rock outcrops are relatively common along the stream bed.

Tidal currents extended up the Kalabakan River as far as the camp site and even a mile farther, to the mouth of the Sungei Tawan. The surface water of the Kalabakan at that point is not brackish

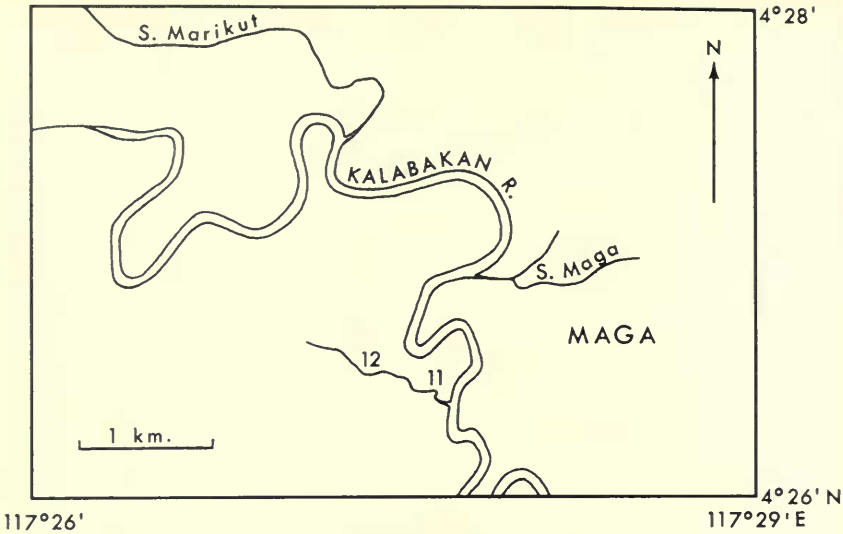

FIG. 108. Map of Kalabakan base, Tawau District, North Borneo.

even at high tide, and only the mouth of the Tawan is affected by these currents.

The Tawan has a muddy bottom extending upstream a short distance from the mouth. About 100 meters from the mouth is a short set of boulder-strewn rapids; here the stream drops one meter. The tidal currents do not reach these rapids.

KALABAKAN STATIONS (fig. 108):

Station 11.—Sungei Tawan, upstream from first rapids (fig. 109). June 6, 1956. Shore vegetation primary dipterocarp forest. No submerged or emergent vascular plants. Banks steep, 2–3 meters high. Bottom mud in pools, with dead leaves; sand, gravel, and rocks in riffles. Maximum width 5 meters; maximum depth in pools 1.5 meters, 10 cm. in riffles. Length of station 200 meters including pools, riffles, rapids, and exposed bedrock. Water clear, bottom visible. Current not measured, "moderate." Previous rainfall: 3.5 mm. on June 4; none on June 5. Sky clear. Shade 30–90 per cent. Time 08:00–13:00. Temperature not recorded. Rotenone.

FAUNA

Anguilla borneensis (3)
A. marmorata (15)
A. bicolor pacifica (11)
Nematabramis everetti (430)
Rasbora sumatrana (1)
Osteochilus spilurus (22)
Nemachilus selangoricus (1)
Leiocassis micropogon (1)
Mystus nemurus (24)
M. baramensis (2)

FIG. 109. Station 11 at Kalabakan base, North Borneo.

Rasbora hubbsi (23)
Leptobarbus melanotaenia (6)
Puntius sealei (10)
P. bramoides (35)
Hampala macrolepidota (3)
Cyclocheilichthys repasson (49)
C. apogon (6)
Clarias teysmanni (3)
Eleotris melanosoma (96)
E. fusca (5)
Stenogobius gymnopomus (15)
Glossogobius giuris (4)
Stigmatogobius oligactis (1)
S. isognathus (10)

Station 12.—One kilometer upstream from Sta. 11. June 8, 1956. Shore vegetation primary dipterocarp forest. No submerged or emergent vascular plants. Banks steep, 1–4 meters high. Bottom silt in pools, with dead leaves; gravel, rocks, and bedrock in riffles. Length of station 200 meters, with same variation as Sta. 11. Water clear, bottom visible. Current in pool 180 meters/hr. Previous rainfall none in two days. Sky partly cloudy. Shade 30–90 per cent. Time 08:00–13:30. Temperature not recorded. Rotenone.

FAUNA

Anguilla borneensis (7)
A. marmorata (26)
A. bicolor pacifica (1)
Nemachilus selangoricus (13)
N. olivaceus (9)
Protomyzon griswoldi (2)

Mastacembelus armatus (4)
Nematabramis everetti (1015)
Rasbora sumatrana (9)
R. hubbsi (29)
R. rutteni (8)
Puntius sealei (19)
P. bramoides (25)
Hampala macrolepidota (6)
Cyclocheilichthys repasson (43)
C. apogon (6)
Osteochilus spilurus (27)
Ompok sabanus (1)
Leiocassis micropogon (4)
Mystus nemurus (47)
M. baramensis (18)
Clarias teysmanni (1)
Eleotris melanosoma (50)
Stenogobius gymnopomus (2)
Stigmatogobius oligactis (6)
S. isognathus (3)
S. javanicus (4)
Awaous stamineus (1)

A rotenone collection was also made just inside the mouth of Sungei Marikut on June 16, 1956. Shore vegetation old secondary growth. No submerged or emergent vegetation. Dead branches in water. Bottom mud. Maximum width 10 meters; maximum depth ca. 3 meters. Water yellowish brown, very turbid.

FAUNA

Anguilla borneensis (1)
A. bicolor pacifica (5)
Nematabramis everetti (6)
Rasbora hubbsi (21)
Puntius bramoides (8)
Hampala macrolepidota (7)
Cyclocheilichthys repasson (54)
Acanthophthalmus anguillaris (2)
Mystus nemurus (30)
M. baramensis (13)
Dermogenys pusillus (1)
Prionobutis dasyrhynchus (3)
Eleotris melanosoma (25)
Stenogobius gymnopomus (25)
Glossogobius giuris (4)
Stigmatogobius oligactis (1)

The Sapagaya Forest Reserve lies in the lowland forest south of Sandakan Harbour. Parts of the forest were logged about twenty years ago, but many large trees were left standing. The topography is undulating, though the ridges are less than 35 meters high. One rotenone station was made on July 26, 1950, in a small, unnamed tributary of the Sungei Sapagaya. The stream was about 3 meters wide and 1 meter deep at its maximum. The bottom was a mixture of mud and small gravel. The water was turbid.

FAUNA

Anguilla borneensis (5)
Mastacembelus keithi (9)
Nematabramis everetti (32)
Rasbora sumatrana (31)
Puntius sealei (35)
Hampala macrolepidota (8)
Nemachilus olivaceus (4)
Mystus baramensis (9)
Clarias teysmanni (2)
Dermogenys pusillus (2)
Ophicephalus melanosoma (2)
Betta unimaculata (13)
Eleotris melanosoma (53)
Glossogobius giuris (1)
Stigmatogobius isognathus (2)

The Sepilok Forest Reserve, lying west of Sandakan, has a few ridges higher than those of Sapagaya. Though parts of the forest

were cut about 20 years ago, the canopy is still more or less unbroken. The soil is clayey in the low spots, sandy on the ridges. A rotenone station was made in a pool 10 meters by 13 meters, below a 5-meter waterfall. Maximum depth was 1.3 meters. The water was turbid and had a very slow current. Numerous dead branches were in the water but no living vascular plants. The bottom was muddy.

FAUNA

Anguilla borneensis (2)
Nematabramis everetti (39)
Rasbora sumatrana (34)
Puntius sealei (32)
Acanthophthalmus sandakanensis (25)
Clarias teysmanni (7)
Ophicephalus melanosoma (3)
Betta unimaculata (10)
Eleotris melanosoma (2)

Distribution with Respect to Turbidity

Though ten species (Table 12) were collected by us only in clear water, no species lives in clear water all the time for at least one reason—the frequent, heavy rainfalls that wash silt into all

Table 12.—Fishes Found Only in Clear or Only in Turbid Fresh Water in North Borneo

(Number of stations and individuals in parentheses)

Turbid Water	Clear Water
Setipinna melanochir (3–10)	*Anguilla marmorata* (2–41)
Coriea soborna (1–1)	*Mastacembelus armatus* (2–5)
Batrachocephalus mino (1–5)	*Leiocassis micropogon* (2–5)
Kryptopterus parvanalis (6–29)	*Cyclocheilichthys apogon* (2–10)
Mystus sabanus (6–17)	*Osteochilus spilurus* (4–146)
Leiocassis robustus (3–7)	*Gastromyzon borneensis* (4–22)
Pangasius tubbi (6–22)	*Nemachilus selangorieus* (2–14)
P. nieuwenhuisi (4–6)	*Protomyzon griswoldi* (2–16)
Acrochordonichthys pachyderma (1–1)	*Stigmatogobius javanieus* (1–4)
A. melanogaster (2–10)	*Awaous stamineus* (1–1)
Chela oxygastroides (2–32)	
Rasbora myersi (5–385)	
Leptobarbus hosii (3–4)	
Puntius bulu (9–39)	
Dangila sabana (8–67)	
Tylognathus caudimaculatus (1–63)	
Acanthophthalmus anguillaris (1–2)	
A. sandakanensis (3–38)	
Osphronemus goramy (6–11)	
Toxotes chatareus (2–2)	
Lutianus argentimaculatus (1–1)	
Prionobutis dasyrhynchus (1–3)	
Tetraodon fluviatilis (1–3)	
Chonerhinus modestus (4–76)	

streams at all times of the year (see p. 23). Two species, *Gastromyzon borneensis* and *Osteochilus spilurus*, may be confined to streams that are clear most of the time. The other clear-water species, collected at only one or two stations, may be in this group merely because of the accidents of sampling. One, *Anguilla marmorata*, must migrate through turbid water in the lower reaches of rivers on its way from the larval marine habitat.

The turbid-water species listed in Table 12 may remain in turbid water all of their lives. With the exception of *Acanthophthalmus anguillaris*, *A. sandakanensis*, *Prionobutis dasyrhynchus*, and *Tetraodon fluviatilis*, these turbid-water fishes are inhabitants of large rivers, their cut-off meanders, or the mouths of their tributaries. The four exceptional species have been collected in small tributaries at some distance from their junctions with major streams.

Coastal and Interior Distributions

By virtue of their proximity to brackish water and their relative isolation, short coastal drainages present an ecological situation that differs from that of interior aquatic habitats.

We are defining as "coastal" all short (less than 50 km. long) streams draining directly into the sea or into bays such as Sandakan Harbour and Dewhurst Bay; these streams are not parts of the major river systems. Coastal streams of this type that we have sampled are Sungei Sapagaya and Sungei Sepilok (drain into Sandakan Harbour); and Sungei Kretam Kechil and its tributaries, Sungei Gaja and Sungei Pinang (drain into Dewhurst Bay). Also included in this category are the lowest 20 km. of the Kalabakan River and its tributary, Sungei Tawan. Large portions of these streams, affected by tidal currents, are brackish. For example, 20 of the 50 km. of stream length in the Kretam Kechil drainage lie in the nipa-mangrove association, an indicator of brackish surface water; because of its greater density brackish water probably extends farther upstream along the bottom.

The types of situations sampled and the method of collection used in these coastal streams were:

1. Small, clear, forest streams with sand, gravel, and rock bottoms. Rotenone used.

2. Small, turbid, forest streams with silt and sand bottoms. Rotenone used.

3. Middle depths at mouth of moderate-sized forest stream. Trammel net used.

4. Large, turbid river. Cast net used.

Only one interior base was sampled intensively, namely, the middle Kinabatangan River and those of its tributaries that centered around Deramakot. This base is far above the reach of tides and brackish water and has a large drainage area upstream from it. Not far downstream from Deramakot, and in an ecologically similar area, a collection was made in an unnamed tributary of the Kinabatangan adjacent to Sungei Tabalin Besar. Sporadic collecting was carried on in some of the interior drainages in western North Borneo (e.g., the Pegalan River and Sungei Tempasuk), but the results will not be considered here because the collecting was not intensive. The types of situations sampled and the methods used at Deramakot and at the Sungei Tabalin Besar included the four listed above for coastal streams plus:

5. Mouth of small, turbid stream with silt bottom. Minnow seine used.

6. Mouth of moderate-sized, turbid stream with silt bottom. Rotenone used.

7. Large, turbid river. Hook-and-line used.

8. Gravel bar in large, turbid river. Minnow seine used.

The most conspicuous difference between the collections made in coastal and interior streams was the greater abundance of marine or brackish-water groups (hemiramphs, percoids, eleotrids, gobiids, and tetraodontids) in the coastal streams (Table 13). These complementary fresh-water fishes (Myers, 1949) formed between 10 and 27 per cent of the total catch in three of the four coastal collections. In the two interior collections, they formed less than 5 per cent of the catch.

The species collected by us in coastal streams but not in the interior are:

Arius microcephalus
Mystus baramensis
Leiocassis micropogon
Chela oxygastroides
Rasbora rutteni
Cyclocheilichthys apogon
Osteochilus spilurus
Acanthophthalmus sandakanensis
Nemachilus selangoricus
Butis gymnopomus
Ophiocara porocephala
Oxyeleotris urophthalmus
Prionobutis dasyrhynchus
Brachygobius doriae
Awaous stamineus
Glossogobius giuris
Stigmatogobius isognathus
S. oligactis

TABLE 13.—Composition of Catch in Terms of Numbers of Individual Fishes Collected at Various Areas of North Borneo

	Coastal								Interior			
	Sepilok		Sapagaya		Kalabakan		Kretam Kechil		Deramakot		Tabalin	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Isospondyli	...		...		...		...		10	00.3	1	00.2
Apodes	2	01.2	5	02.4	69	02.8	88	05.5	86	03.0	...	
Opisthomi	...		9	04.3	4	00.1	...		31	01.0	...	
Cyprinoidea	130	84.4	110	52.9	1976	80.4	1075	67.6	2365	83.4	429	94.9
Siluroidea	7	04.5	11	05.3	146	05.9	27	01.6	229	08.0	21	04.6
Ophicephalidae	3	01.9	2	01.0	...		3	00.1	3	00.1	...	
Anabantoidea	10	06.4	13	06.3	1		54	03.3	17	00.5	...	
Hemiramphidae	...		2	01.0	1		27	01.6	6	00.2	...	
Percoidea	...		...		3	00.1	3	00.1	10	00.3	...	
Eleotridae	2	01.2	53	25.5	179	07.2	71	04.4	3	00.1	...	
Gobiidae	...		3	01.4	76	03.0	78	04.9	...		1	00.2
Tetraodontidae	...		...		2	00.1	163	10.2	75	02.6	...	
Total	154		208		2457		1589		2835		452	
Ostariophysi	*137*	*88.9*	*121*	*58.2*	*2122*	*86.3*	*1102*	*69.2*	*2594*	*91.4*	*450*	*99.5*
Complementary fresh-water species		01.2		27.9		10.4		21.2		03.2		00.2

Monopterus alba
Anguilla marmorata
A. bicolor pacific
Ambassis interrupta
Eleotris fusca
Butis butis
S. javanicus
Redigobius bikolanus
R. chrysosoma
Tetraodon fluviatilis
T. kretamensis
T. leiurus

The presence on this list of three of the ostariophysine species (*Leiocassis micropogon, Cyclocheilichthys apogon,* and *Chela oxygastroides*) may result from geographic rather than ecological factors; they have been found only in the southernmost drainage area (Kalabakan) and may be relatively recent arrivals in eastern North Borneo. Other coastal ostariophysine species, such as *Osteochilus spilurus* and *Acanthophthalmus sandakanensis*, have eological replacements in the interior bases, i.e., congeners that live in the same vertical strata and have similar feeding habits; for example, *O. spilurus* is replaced by *O. microcephalus* and *A. sandakanensis* by *A. mariae.*

The striking aspect of the list, however, is that more than half of the species belong to ordinarily marine or brackish-water families (Ambassidae, Eleotridae, Gobiidae, and Tetraodontidae).

It has been suggested (Inger, 1955) that the abundance of these marine groups is determined by the abundance or scarcity of Ostariphysi, especially the cyprinoids. This idea is supported by the data in Table 14, in which the total catches are broken down into the numbers of species belonging to each family or higher category. The two interior collections had much larger proportions of ostariophysine species and correspondingly lower proportions of the complementary fresh-water fishes (gobies, eleotrids, etc.).

Turbidity is not an important factor in the distribution of the "coastal" fishes considered as a group, because some were collected only in clear water (e.g., *Leiocassis micropogon, Osteochilus spilurus;* see Table 12), some only in turbid water (e.g., *Chela oxygastroides, Prionobutis dasyrhynchus*), and the majority in both clear and turbid waters. Similarly, these coastal species were found associated with all types of bottoms, varying currents, and small as well as large streams.

Flooding

The short, heavy rainfalls common over most of Borneo (see p. 23) cause aperiodic, radical fluctuations in aquatic environments. A river as large as the Kinabatangan exhibits startling changes, rising 2 to 5 meters overnight even during the months (April and May)

TABLE 14.—Composition of Catch with Respect to Numbers of Species Collected at Various Areas of North Borneo

	Coastal								Interior			
	Sepilok		Sapagaya		Kalabakan		Kretam Kechil		Deramakot		Tabalin	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Isospondyli	..		..		..		..		1	01.9	1	07.1
Apodes	1	11.1	1	06.7	3	07.6	1	04.1	1	01.9	..	
Opisthomi	..		1	06.7	1	02.5	..		2	03.8	..	
Cyprinoidea	4	44.4	5	33.3	15	38.4	6	25.0	25	48.0	10	71.4
Siluroidea	1	11.1	2	13.3	6	15.3	2	08.3	13	25.0	2	14.2
Ophicephalidae	1	11.1	1	06.7	..		1	04.1	1	01.9	..	
Anabantoidea	1	11.1	1	06.7	2	05.1	1	04.1	2	03.8	..	
Hemiramphidae	..		1	06.7	1	02.5	1	04.1	1	01.9	..	
Percoidea	..		..		1	02.5	1	04.1	3	05.7	..	
Eleotridae	1	11.1	1	06.7	3	07.6	5	20.8	1	01.9	..	
Gobiidae	..		2	13.3	6	15.3	4	16.7	1	01.9	1	07.1
Tetraodontidae	..		..		1	02.5	2	08.3	1	01.9	..	
Total	9		15		39		24		52		14	
Ostariophysi	*5*	*55.5*	*7*	*46.6*	*21*	*53.7*	*8*	*33.3*	*38*	*73.0*	*12*	*85.6*
Complementary fresh-water species		11.1		26.7		29.4		54.0		13.3		07.1

of minimal rainfall. During our 23-day period of observation at Deramakot (April–May, 1956), the Kinabatangan rose 2.5 to 4 meters within twelve hours on three separate days. Midstream current on two of those occasions was 4.5–4.8 km. per hour. Large amounts

FIG. 110. Debris carried by Kinabatangan River after a rise of 4 meters in May, 1956.

of silt and debris are carried by the river at each rise (fig. 110). The local river people insist that only at such times is it possible to catch certain species with hook-and-line; they pointed to *Leiocassis robustus* as an example.

Small streams are also subject to flooding. A small, clear, forest stream only 2 meters wide and perhaps 0.5–1.5 meters deep may in two hours change to a raging torrent 10 meters wide and 2–3 meters deep, carrying heavy loads of silt and debris with a force a man could not stand against. These were the effects of a 75 mm. rainfall on the Sungei Gaja (a small tributary of the Kretam Kechil) observed in May, 1950, and must be repeated frequently in most streams in Borneo (see p. 23).

After the crest of such a flood passes, the stream remains turbid for varying lengths of time—usually more than a day—and for that period has some of the characteristics of streams in the flat areas of the Kinabatangan basin. Fishes living in these streams must

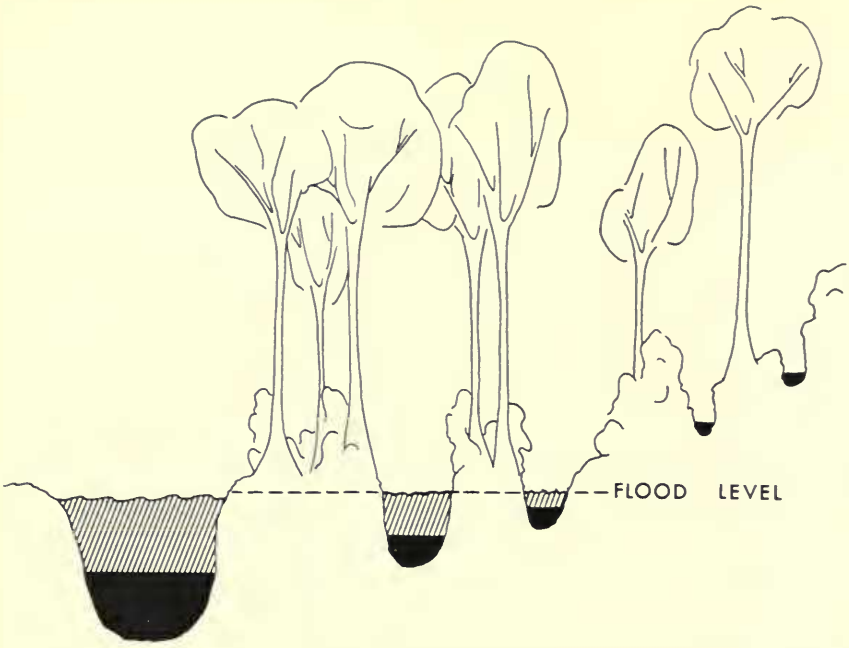

FIG. 111. Drainage profile and effect of flooding in flat basins of eastern North Borneo. Solid black indicates "normal" level of water.

be able to tolerate turbid water and temporary deposits of silt for short periods at relatively frequent intervals.

Small streams in the flat portions of the Kinabatangan and presumably in the Segama and Labuk basins flood in response to heavy rains in their own watersheds. But, unlike streams in hilly or mountainous areas such as the Kalabakan or Tempasuk basins, the small tributaries in the flat basins are affected by rains falling in other parts of the drainage. Small streams cut deeply in these alluvial areas; a stream only one meter wide may have banks 2 to 3 meters high. Because of the flatness of the land and the deep cuts of tributaries, a rise in the level of the main river following heavy rains upstream often causes the water to back up into the tributaries (fig. 111). Thus the small streams in the flat basins flood oftener than hill streams and in two very different ways. Floods originating in a watershed—the only kind possible in a hill stream—cause strong currents and erosion of the stream bed. Those originating outside the watershed are accompanied by very slow currents (which are often directed upstream) and heavy deposition of silt.

At low water the Sungei Deramakot was less than 3 meters wide and less than 1 meter deep at its mouth; each time the Kinabatangan rose, the lower reaches of the Deramakot enlarged to a width of approximately 20 meters and a depth of 3 meters. Rainfall at Deramakot in the 24-hour periods immediately preceding the three river rises we observed was none, 7 mm., and 52 mm. Only the last could have contributed to a change in water level. At the same time, a stream draining a hill (ca. 200 meters above the level of the river) immediately adjacent to the Sungei Deramakot was not affected by the changes in the Kinabatangan's level except at its very mouth.

The increased depth and width of flooded tributaries in the flat areas enable large river fishes to enter these streams, some to feed and probably some to breed. At Pintasan, 50 km. downstream from Deramakot, we saw three large *Wallago maculatus* and three large *Mystus* (probably *nemurus*) caught in a small flooded tributary of the Kinabatangan. The owner of the trap assured us that large *Mystus* were found in the tributary only at high water. Information on the movement of fishes into tributaries was also obtained by setting a trammel net just inside the mouth of the Sungei Deramakot each time flood waters backed up the stream. The fishes caught in the trammel net (Table 15) either represented species that were not collected in the small forest streams (Stas. 3–8) of the Kinabatangan area (*Kryptopterus parvanalis, Pangasius tubbi, Setipinna melanochir*) or were larger individuals of a species (*Cyclocheilichthys repasson*) also caught in the small tributaries. The trammel-net captives were larger than individuals of the same species caught in the Kinabatangan with a cast net.

Rotenone collections made in the flooded Sungei Deramakot included other species—*Batrachocephalus mino, Puntius bulu, Dangila sabana, Toxotes chatareus,* and *Lutianus argentimaculatus* –that were not obtained in the small forest tributaries, even those (e.g., Sta. 3 and 4) having silty bottoms and turbid water similar to the lower reaches of the Sungei Deramakot.

At least two of the species, *Setipinna melanochir* and *Lutianus argentimaculatus,* associated with flooded conditions in the Sungei Deramakot are predators on fishes. The large species of *Mystus* in the traps at Pintasan contained crabs, as well as fishes of the genera *Clarias* and *Kryptopterus.* Flooding, therefore, exposes the populations of otherwise small streams in the flat areas to predators larger than those normally carried in these streams. The populations

TABLE 15.—Comparison of Collections of Certain Fishes from the Vicinity of Deramakot, North Borneo

	Sungei Deramakot Trammel Net[1]		Kinabatangan River Cast Net		Forest Tributaries[2] Rotenone	
	No.	Standard length (mm.)	No.	Standard length (mm.)	No.	Standard length (mm.)
Setipinna melanochir	4	230–260 (mean 240)	5	127–180 (mean 146)	0	
Cyclocheilichthys repasson	4	150–180 (mean 162)	2	75, 113	38	57–117
Pangasius tubbi	1	228	2	108, 112	0	
Kryptopterus parvanalis	18	201–244 (mean 225)	7	101–202 (mean 145)	0	

[1] Set when the rising Kinabatangan backed up the Sungei Deramakot.

[2] Excluding rotenone collections made in the flooded lower reaches of the Sungei Deramakot.

of small hill streams in the immediate vicinity, unaffected by floods in the main river, are not exposed to additional large predators.

Food and Feeding Relations

Most of the specimens examined had empty stomachs, probably because of the time of capture, and information on the diets of these fishes is, therefore, fragmentary. The total number of food-containing stomachs examined was 320, taken from 49 species. The number per species varied from 2 to 43, with 5 to 11 the commonest class. Because of the small numbers involved, the conclusions in the following discussion are tentative and will require much more work in the field to be substantiated. Observations on the strata in which certain species feed are reliable and the connection between the behavior and the diet often is obvious.

Based on the evidence of the stomachs examined, a generalized and simplified food web of North Bornean streams has been drawn (fig. 112). As our attention was focused on the fish community, the roles of the invertebrates are considered only in terms of their impact on the fishes; undoubtedly we have thereby eliminated most of the complexities of the trophic relations. The words "herbivore," "predator," and "omnivore" refer to fishes, although other vertebrates (frog larvae, birds, mammals, and reptiles) share in these roles. The predatory fishes are arranged in order of increasing size of prey. Though the young of predaceous fishes feed on smaller prey than the adults, in the list below each species is placed on the basis of predominant adult diet. Herbivorous fishes, especially of group A, and the first order predators probably eat one food size category at all stages of development.

Herbivores A (food source endogenous): *Lobocheilus bo, Schismatorhynchus heterorhynchus, Osteochilus spilurus, O. microcephalus, O. vittatus, Dangila sabana, Epalzeorhynchus kalliurus, Garra borneensis,* and *Gastromyzon borneensis.* Though few stomachs of some of these species were examined, all individuals had their digestive tracts packed with detritus. The extrapolation from the few stomachs to the characterization of the species is probably safe in these cases. These detritus feeders engulf fine particles from the bottom and in the process invariably swallow large quantities of mud and fine grains of sand along with the actual food, which usually consists of diatoms, blue-green algae, filamentous algae, fungal hyphae and spores, and, less often, fragments of vascular plants. The digestive

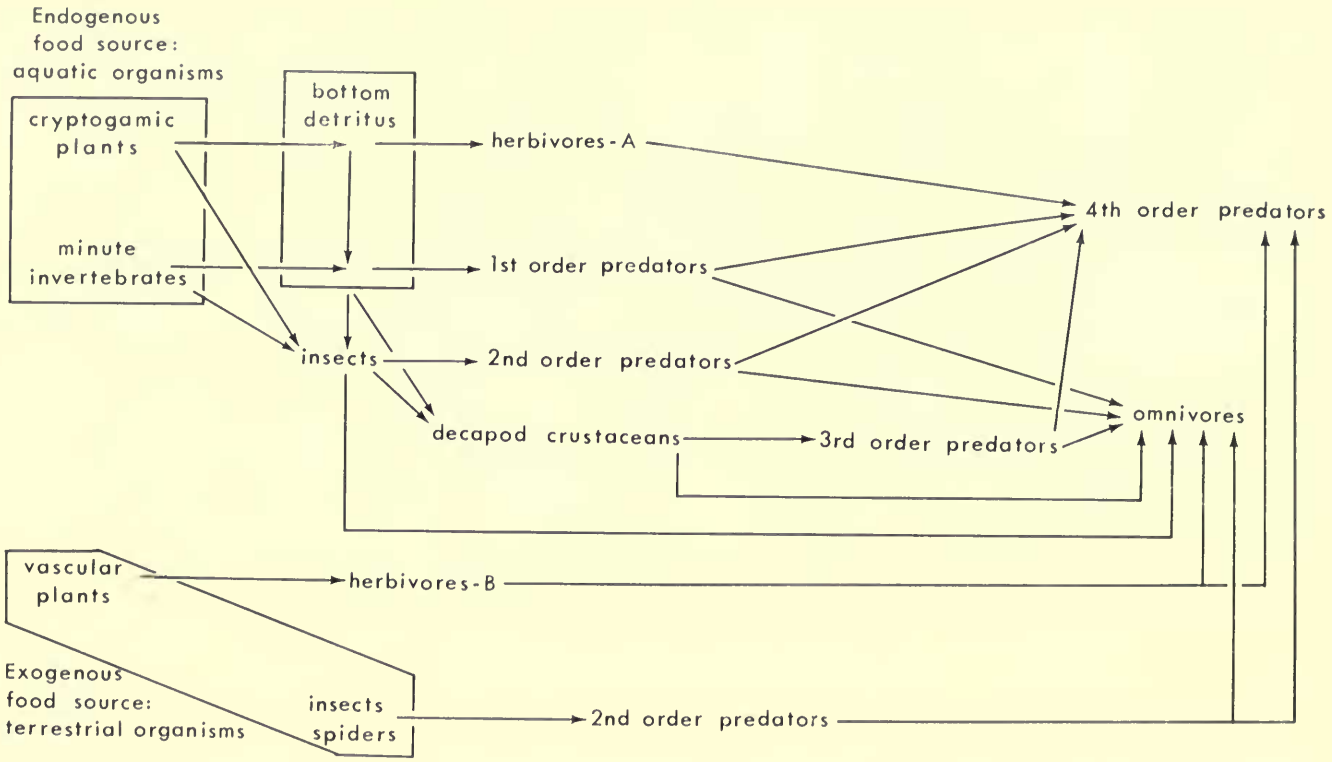

FIG. 112. Generalized food web in small forest stream in eastern North Borneo. "Herbivores," "predators," and "omnivores" refer to fishes only.

tracts of these fishes are extremely long and convoluted (Table 16) and the stomachs are not as grossly differentiated from the intestines as in some other fishes.

TABLE 16.—Relation of Gut Length to Standard Length in Detritus Feeding Fishes of North Borneo

	Standard length (mm.)	Gut length (mm.)	Ratio gut:body	Dominant food
Osteochilus spilurus	104	1130	10.9	plant
	110	1200	10.9	plant
Osteochilus microcephalus	72	557	7.7	plant
Lobocheilus bo	72	670	9.3	plant
Garra borneensis	59	253	4.3	plant
Epalzeorhynchos kalliurus	54	220	4.1	plant
Acanthopsis choirorhynchus	74	37	0.5	animal
Stenogobius gymnopomus	50	55	1.1	animal

Herbivores B (food source exogenous): *Leptobarbus melanotaenia, Puntius bulu, P. binotatus, P. bramoides, P. sealei, Batrachocephalus mino,* and *Chonerhinus modestus.* Fragments of vascular plants were found in 50 to 100 per cent of the food-containing stomachs of these species. Plant fragments occurred in 7 to 25 per cent of the stomachs of *Nematabramis everetti, Rasbora sumatrana, Cyclocheilichthys repasson, Clarias teysmanni, Mystus nemurus,* and *Tetraodon kretamensis.*

The digestive tracts of these plant feeders contained flowers, fruits, seeds, leaves, and pieces of stems of vascular plants. No aquatic vascular plants were observed at any collecting station, though algae grew on rocks in swift, clear water. From the overhanging forest a continuous shower of plant material falls on all streams, and this shower provides the plant material eaten by the fishes in this category. The plop of a fruit or large flower hitting the surface is often followed by the strike of a fish, in our experience usually *Puntius bulu.* At certain times great quantities of small flowers drift down from trees and lianas to float on the surface. Flowers of this type found in fish stomachs were almost certainly eaten at the surface. Denser seeds and stems probably sink and may have been eaten after they had been submerged and possibly softened. With the exception of *Tetraodon kretamensis* and *Chonerhinus modestus,* all of the plant feeders are Ostariophysi; probably they did not bite off pieces of the plant material but engulfed it in the form in which it was found. *Tetraodon* apparently picked up fragments also. *Chonerhinus,* however, obviously snipped off

pieces of leaves with its sharp teeth, as the shape of each piece removed from stomachs reflected the shape of the fish's dentition, i.e., one convex edge and parallel to it a concave edge.

First order predators (food source endogenous): *Acanthopsis choirorhynchus* and *Stenogobius gymnopomus.* The digestive tracts of these species were filled with mud and fine grains of sand. Though feeding on detritus, their food is primarily animal: nematodes, very small insect larvae, entomostracans, rotifers, etc. Their digestive tracts are almost straight and much shorter than those of the herbivorous detritus feeders (Table 16). At several places (Stas. 7, 10) *Acanthopsis choirorhynchus* was collected simultaneously with the herbivorous detritus feeders *Osteochilus microcephalus, Lobocheilus bo, Schismatorhynchus heterorhynchus, Epalzeorhynchos kalliurus,* and *Garra borneensis.* At Sta. 10, a gravel bar in the Kinabatangan River, *Acanthopsis, Lobocheilus,* and *Schismatorhynchus* were caught in the same seine hauls.

Second order predators (food source endogenous): *Mastacembelus armatus, Anguilla bicolor pacifica, Nemachilus selangoricus, N. olivaceus, Ompok sabanus, Clarias teysmanni, Mystus sabanus,* and *Butis gymnopomus.* From 45 to 100 per cent of their stomachs contained aquatic insects, mainly in immature stages. All of these species are bottom dwellers except *Ompok,* a surface fish, and *Mystus sabanus,* a fish of unknown habits. Probably the other species of *Mastacembelus* belong in this group. Aquatic insects appeared in 20 to 40 per cent of the stomachs examined of *Anguilla marmorata, Cyclocheilichthys repasson, Tetraodon kretamensis,* and *Chonerhinus modestus* and in 10 to 15 per cent of those of *Anguilla borneensis, Mystus nemurus,* and *Betta unimaculata.*

Second order predators (food source exogenous): *Nematabramis everetti, Rasbora myersi, R. sumatrana, Luciosoma pellegrini, Dermogenys pusillus, Betta unimaculata,* and *Periophthalmodon tredecemradiatus.* Terrestrial insects and spiders were found in 75 to 100 per cent of the stomachs examined. Two of these species, *Nematabramis everetti* and *Dermogenys pusillus,* swim right at the surface (p. 225) and are in a good position to grab insects hitting the surface. *Periophthalmodon tredecemradiatus* feeds on land. The species of *Rasbora* and *Luciosoma* are in constant motion a little below the surface. As insect fragments (unidentifiable) were found in the stomachs of *Rasbora* species other than the two listed and since all of the Bornean species seem to have similar activities, probably all of the North Bornean species of *Rasbora* belong in this category.

One-third to one-half of the stomachs examined of *Puntius bramoides, P. sealei, Clarias teysmanni, Ambassis interrupta,* and *Chonerhinus modestus* contained terrestrial insects. With the exception of *Clarias teysmanni,* which is a bottom-dwelling fish, these species are mid-water fishes. Terrestrial insects were found in 10 to 30 per cent of the stomachs examined of *Anguilla borneensis, Nemachilus selangoricus, Ompok sabanus, Mystus sabanus, M. nemurus, Ophicephalus melanosoma,* and *Tetraodon kretamensis.*

Terrestrial insects and spiders, like parts of vascular plants, represent an important exogenous source of food. Most of the insects found in stomachs were ants, which probably fell from vegetation overhanging the water. The other insects recovered, such as Coleoptera and Hemiptera, may have flown or jumped into the water accidentally. The spiders included here may be riparian and have been washed into streams, or may be arboreal and have fallen into the water. Heavy rains probably wash insects and spiders living on banks into the water and also knock arboreal forms off their substrate. Either way, the number of terrestrial arthropods brought into the aquatic environment is great enough to support a large segment of the fish community.

Cyclocheilichthys repasson and *C. apogon* are second order predators. Of the 13 stomachs examined 12 contained fragments of insects that could not be identified certainly as either terrestrial or aquatic.

Third order predators (food source endogenous): *Anguilla borneensis, Mystus baramensis, Eleotris melanosoma, Glossogobius giuris.* From 50 to 75 per cent of the stomachs of these species contained crabs or prawns. These decapod crustaceans are conspicuous and abundant in all Bornean streams. *Anguilla borneensis* is a bottom dweller and probably the other species live close to if not on the bottom.

Decapods, mostly crabs, appeared in 25 to 33 per cent of the stomachs of *Clarias teysmanni, Mystus nemurus, Ophicephalus melanosoma, Butis gymnopomus,* and *Tetraodon kretamensis,* all bottom fishes except *T. kretamensis.* Between 10 and 20 per cent of the stomachs of *Setipinna melanochir, Anguilla marmorata, Puntius sealei, Betta unimaculata, Ambassis interrupta,* and *Periophthalmodon tredecemradiatus* contained fragments of decapods. This last group of fishes occupies a variety of strata, *Anguilla marmorata* the bottom, *Septipinna melanochir,* and *Puntius sealei* mid-water, and *Periophthalmodon tredecemradiatus* the banks. As prawns and crabs often

were seen out of water at night on rocks in mid-stream or on banks, *Periophthalmodon tredecemradiatus* may catch these crustaceans on land.

Fourth order predators (food source endogenous): *Setipinna melanochir, Hampala macrolepidota, Ophicephalus melanosoma.* Fishes and other vertebrates appeared in more than 50 per cent of the stomachs of these fishes. Fishes occurred in much less than 50 per cent of the stomachs of *Luciosoma pellegrini, Mystus nemurus, Betta unimaculata, Ambassis interrupta, Eleotris melanosoma, Butis gymnopomus, Glossogobius giuris,* and *Chonerhinus modestus.* As they themselves are small (maximum around 100–125 mm.), *Betta, Eleotris,* and *Ambassis* are able to prey only on small fishes and feed largely on invertebrates. Presumably many of the second and third order predators feed on small fishes to some extent. The size range of prey of *Hampala, Mystus nemurus,* and *Ophicephalus* is not so limited as these fishes become large (frequently more than 500 mm.).

Omnivores (food source endogenous): *Anguilla marmorata, Mystus nemurus,* and *Tetraodon kretamensis.* The diets of *M. nemurus* and *T. kretamensis* comprise almost equal portions of decapod crustaceans, terrestrial insects, aquatic insects, and vascular plants, with crustaceans forming the largest portion in the diet of *M. nemurus* though still less than half. Endogenous food sources are more important than exogenous ones in both diets. The diet of *A. marmorata* consists primarily of aquatic organisms, but none of the categories used here appeared in more than 50 per cent of the stomachs.

The diets of a significant number of species could not be determined at three of the collecting bases in eastern North Borneo (Table 17). Judged by the length of the intestines, only one (*Protomyzon griswoldi* from Kalabakan) of the indeterminate species probably feeds on cryptogamic aquatic plants. All of the others have relatively short digestive tracts and probably feed on invertebrates. Insect fragments of uncertain origin were found in one or two stomachs of several species (see also comments on two *Cyclocheilichthys* species, p. 219). The safest assumption is that these indeterminate feeders will be distributed in three or more of the predaceous classes and probably in proportion to the numbers now known in those classes (Table 17).

The numbers of species directly utilizing exogenous food equals one-half or more of those primarily eating endogenous food, except at Tabalin. The number of species feeding mainly on terrestrial insects equals or exceeds the number feeding on aquatic insects

TABLE 17.—Food Preference, by Species, of Fishes from Various North Bornean Areas
(Food preference determined by numbers of individuals containing type of food.)

	Sepilok		Sapagaya		Kretam-Kechil		Kalabakan		Deramakot								Tabalin	
									Stas. 2, 9		Stas. 3–8		Sta. 10		All stas.			
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Exogenous																		
Plants	1	*11*	1	*06*	1	*04*	3	*08*	3	*16*	4	*13*	2	*10*	7	*16*	0	..
Insects	3	*33*	4	*27*	4	*17*	5	*13*	4	*21*	7	*22*	3	*15*	9	*20*	2	*14*
Subtotal	4	*44*	5	*33*	5	*21*	8	*21*	7	*37*	11	*35*	5	*25*	16	*36*	2	*14*
Endogenous																		
Plants	0	..	0	..	1	*04*	1	*03*	4	*21*	6	*19*	5	*25*	7	*16*	6	*43*
Invertebrates																		
First order	0	..	0	..	0	..	1	*03*	0	..	1	*03*	1	*05*	1	*02*	1	*07*
Second order (insects)	1	*11*	3	*20*	2	*08*	6	*15*	3	*16*	5	*16*	3	*15*	6	*13*	2	*14*
Third order (decapods)	2	*22*	4	*27*	3	*13*	4	*10*	0	..	2	*06*	0	..	2	*04*	1	*07*
Fishes	1	*11*	2	*13*	2	*08*	1	*03*	2	*11*	2	*06*	0	..	4	*09*	0	..
Miscellaneous	0	..	0	..	2	*08*	2	*05*	1	*05*	1	*03*	1	*05*	1	*02*	0	..
Subtotal	4	*44*	9	*60*	10	*42*	15	*39*	10	*53*	17	*53*	10	*50*	21	*46*	10	*71*
Indeterminate	1	*11*	1	*06*	9	*37*	16	*41*	2	*11*	4	*13*	5	*25*	8	*18*	2	*14*
Total number of species	9		15		24		39		19		32		20		45		14	

(invertebrates of second order) at all bases except Kalabakan (Table 17). The number feeding mainly on fragments of terrestrial plants approximates or exceeds the number feeding on aquatic (cryptogamic) plants except at Station 10 of Deramakot, which was a gravel bar at mid-stream in the Kinabatangan River, and at the Tabalin site, which was the mouth of a small, muddy tributary. The complete absence of such herbivores as the species of *Puntius* from the Tabalin station can be explained only as an accident of sampling, for they were caught at an ecologically similar station at Deramakot (Station 2).

The distribution of individuals in these food categories (Table 18) bears out the importance of exogenous food. Fishes of all ages and sizes are categorized according to the diets of adults and subadults, thus introducing some distortion. As already suggested (p. 215), herbivores of group A and first order predators probably show no age variation in diet. The proportion of very small individuals in the catch of all second order predators was small, so that the distortion in Table 18 in these categories is not great. Furthermore, this distortion should not change the relation between "exogenous" and "endogenous" second order predators. The grouping of all ages in the fish predators obscures the numbers feeding on invertebrates; but the proportion of this category in the total catch is small. Thus, despite some distortions, Table 18 gives a reasonably good estimate of the relative importance of various food sources. From 40 to 75 per cent of the individuals that were caught fed primarily on exogenous food.

The comparison made earlier (Inger, 1955) of the diets of Bornean fishes with those of temperate zone fishes requires change, in view of the more extensive information now available. The temperate faunas included no species of indeterminate diets. On the assumption that the indeterminate species in the Bornean fauna would be distributed according to the proportions now in the various feeding categories, the indeterminate species have been eliminated in Table 19 in order to facilitate comparison with the temperate faunas. Terrestrial animals (almost exclusively insects) are clearly more important and aquatic animals correspondingly less important in the economy of North Bornean fish assemblages than in that of temperate faunas. Terrestrial plants were a much more important source of food for the Bornean communities than for those of the temperate zone. All of the Bornean collections were made in forested country, whereas the northern collections were made in cleared as well as wooded ter-

TABLE 18.—Food Preference, by Individuals, of Fishes from Various North Bornean Areas

	Sepilok		Sapagaya		Kretam Kechil		Kalabakan		Deramakot								Tabalin	
									Stas. 2, 9		Stas. 3–8		Sta. 10		All stas.			
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Exogenous																		
Plants	32	20.7	35	16.8	116	07.3	151	06.1	41	34.4	193	13.5	68	05.8	302	11.0	0	...
Insects	83	53.8	78	37.5	842	53.0	1543	62.8	13	10.9	378	26.3	424	36.2	815	29.9	281	62.1
Subtotal	115	74.5	113	54.3	958	60.3	1694	68.9	54	45.3	571	39.7	492	42.0	1117	40.9	281	62.1
Endogenous																		
Plants	0	....	0	....	101	06.4	49	01.9	5	04.2	336	23.4	478	40.8	819	30.1	103	22.7
Invertebrates																		
First order	0	....	0	....	0	....	42	01.7	0	....	57	04.0	23	01.9	80	02.9	1	00.2
Second order (insects)	7	04.5	15	07.2	35	02.2	49	01.9	7	05.9	131	09.1	85	07.3	223	08.2	20	04.4
Third order (decapods)	4	02.5	68	32.7	136	08.6	223	09.0	0	....	89	06.2	0	....	89	03.3	0	....
Fishes	3	02.0	10	04.8	100	06.3	19	00.7	6	05.0	19	01.3	0	....	25	00.9	0	..
Miscellaneous	0	....	0	....	182	11.4	143	05.8	26	21.8	65	04.5	4	00.3	95	03.5	2	00.4
Subtotal	14	09.0	93	44.7	554	34.9	525	21.0	44	36.9	697	48.5	590	50.5	1331	48.9	126	27.7
Indeterminate	25	16.2	2	00.9	77	04.8	238	09.6	21	17.6	165	11.5	89	07.6	275	10.1	45	10.0
Total number of specimens	154		208		1589		2457		119		1433		1171		2723		452	

TABLE 19.—Frequency Distribution with Respect to Main Food Source of Species of Fishes from North Borneo and from Areas in Temperate Zone

Food	Sepilok		Sapagaya		Kretam Kechil		Kalabakan		Tabalin		Deramakot		England[1]		Michigan[2]		New York[3]		New York[4]	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Terrestrial animals	3	*38*	4	*29*	4	*27*	5	*22*	2	*17*	9	*24*	0	..	0	..	4	*06*	9	*14*
Aquatic animals	4	*50*	9	*64*	9	*60*	14	*61*	4	*33*	14	*38*	10	*91*	15	*93*	53	*83*	46	*70*
Aquatic plants	0	..	0	..	1	*06*	1	*04*	6	*50*	7	*19*	1	*09*	1	*07*	7	*11*	11	*17*
Terrestrial plants	1	*12*	1	*07*	1	*06*	3	*13*	0	..	7	*19*	0	..	0	..	0	..	0	..
Total	8		14		15		23		12		37		11		16		64		66	

[1] Hartley (1948).

[2] Hankinson (1908).

[3] Sibley (1929).

[4] Rimsky-Korsakoff (1930).

rain. A more reliable comparison would use data from temperate communities in forest streams.

Vertical Distribution Within Streams

The strata occupied by various species were determined by direct observation in clear water in some cases, by inference from the body form in others, and by inference from the contents of the gut in a few others. Most of the direct, visual observations were made in shallow streams (maximum depths ca. 1.5 meters) with clear visibility to the bottom.

Surface layer (0–5 cm.): *Nematabramis everetti*, *Chela oxygastroides*, *Dermogenys pusillus*, and *Ompok sabanus*. All of these were conspicuous and the first three often broke the surface film with their snouts or beaks. *Ompok sabanus* is evidently not so rigidly confined to the surface. *Tetraodon kretamensis* and *Chonerhinus modestus* were both seen at the surface frequently, but the degree of restriction to that level is uncertain because observations were made in turbid water or in very shallow streams (less than 10 cm. deep).

Upper strata (ca. 5–20 cm.): *Luciosoma pellegrini* and the species of *Rasbora* were in constant motion and easily seen in these layers.

Mid-water: *Leptobarbus melanotaenia*, the species of *Puntius*, and the species of *Cyclocheilichthys* were seen at various levels, though mainly at middle depths. *Cyclocheilichthys repasson* was caught in a trammel net at depths between 40 and 150 cm., *Setipinna melanochir* between 30 and 95 cm., and *Kryptopterus parvanalis* between 35 and 100 cm., all where maximum depth was 3 meters.

Lowest 30 to 40 cm.: *Lobocheilus bo* and the species of *Osteochilus* were always seen just above the bottom. *Mystus nemurus* was seen at this level in Sarawak and probably occupies the same level in North Borneo. Presumably *Schismatorhynchus heterorhynchus* and *Dangila sabana*, because of their feeding habits (p. 215), also live in these lower strata.

Bottom: *Gastromyzon borneensis* and *Acrochordonichthys melanogaster* were seen on the bottom or clinging (*Gastromyzon*) to boulders projecting up from the bottom. The species of *Acanthophthalmus* and *Nemachilus* are known, outside of Borneo, to burrow into stream bottoms habitually (Smith, 1945). Certain fishes have the habitus of bottom dwellers and may safely be placed in this category. Among them are species of *Clarias*, *Garra borneensis*, *Epalzeorhynchos kalliurus*, the species of *Protomyzon*, *Glaniopsis hanitschi*, *Homalop-*

tera weberi, and the species of *Anguilla* and *Mastacembelus*. The contents of the digestive tracts of *Acanthopsis choirorhynchus* and *Stenogobius gymnopomus* (p. 218) indicate that they too live on the bottom.

As shown in Table 20, most of the forest streams had one or two surface species, one or two living just below the surface, three to five mid-water species, two to four living just above the bottom, and three to ten living on or in the bottom. The differences in number of species at a given level within a drainage result partly from the nature of the bottom and the current. For example, at Deramakot Station 5, which had a bottom consisting largely of silt and sand with a few large rocks, the number of bottom-dwelling fishes was absolutely and relatively smaller than at Station 6 just upstream. Part of Station 6 consisted of riffles having a current of about 480 meters per hour (60 m./hr. at Station 5) and a bed of large rocks and some gravel. The riffle provided a habitat for the benthic species *Gastromyzon borneensis* and *Homaloptera weberi*, neither of which occurred at Station 5.

Close to the sources of these small streams, the fish communities become impoverished in a way that affects the different strata differently. As the stream becomes smaller, it usually becomes shallower. The layers occupied by the surface fishes and by the benthic species remain, but the middle layers are compressed. As a result the relative importance of the surface and benthic species remains constant or increases, whereas that of the species living between the surface and the bottom decreases (Table 21). No fishes were found upstream from Deramakot Station 8 and Kretam Kechil Station 5; fishes did live above Deramakot Station 4 but we neglected to collect in that area. The Kalabakan drainage is omitted from Table 21, as no collection was made at its sources.

Some of the differences between drainages result from geographic impoverishment. Sungei Gaja, a small stream in the Kretam Kechil drainage (Stations 3–5; Inger, 1955) had the gross aspects (Table 20) of the hill stream at Deramakot (Stations 5–8) and Sungei Tawan (Stations 11 and 12) in the Kalabakan drainage. Its depth, type of water, current, etc., indicate that the Gaja could support as many species in the various strata as the small streams at Deramakot and Kalabakan. Whereas those streams have 7 to 11 species occupying the middle strata, the Gaja has only 4. This difference almost certainly results from the impoverishment of the ostariophysine fauna in the Kretam Kechil drainage (Table 13).

Stratification in the major rivers is virtually unknown. Deramakot Station 10, a gravel bar in mid-river, represents a special situation in a river, and its fauna has roughly the same stratification as the hill stream (Stas. 5–8). Stations 2 and 9 at Deramakot and the station at Tabalin were in or near the mouths of tributaries of the Kinabatangan; the vertical distributions of their fishes are too different to permit any generalizations about this habitat or any extrapolations to the situation in the river itself.

The physical aspects of Deramakot Stations 2 and 9 were very similar to those of the area fished in the Sungei Marikut (pp. 194 and 204). Of the 33 species collected at these two sets of stations, only two (*Mystus nemurus* and *Cyclocheilichthys repasson*) occur in both places. Nonetheless, the stratification of individual fishes in these communities is similar. One of the striking features of these assemblages is the small number of fishes in the two upper layers.

Fishes dying of rotenone poisoning rise to the surface, and if they are deep layer species they dive to the bottom after a short while. Surface or near-surface fishes, however, remain at the surface while moribund, and sink only after death. In turbid streams, especially those more than a meter deep, dying upper-layer fishes are more likely to be recovered than deeper-layer ones. The paucity of upper-layer fishes in the Deramakot and Marikut collections, therefore, probably reflects the true nature of the fauna and does not result from method of collection.

The Deramakot and Tabalin communities are much closer geographically and taxonomically (9 of 24 species in common) than either is to the Marikut community, yet they differ more in stratification of individuals than do the Deramakot and Marikut assemblages. The principal non-biological difference between the Tabalin station, on the one hand, and the Marikut and Sungei Deramakot stations on the other, is the method of collection. But since the main distinction of the Tabalin collection is its relatively large proportion of fishes from the two upper layers, i.e., those strata that should have been favored at Deramakot (Stas. 2 and 9) and Marikut (see above), the methods of collection probably do not account for the differences in stratification between Tabalin and the two other places. As the Tabalin and Deramakot collections were made within an eighteen-day period, a seasonal factor is probably not involved. Apparently the only explanation of these differences in stratification is the "accidents of sampling."

TABLE 20.—Stratification of Fish Communities in Streams of Various Characters in Eastern North Borneo

	Deramakot					
	Lowland stream		Unnamed hill stream			
Station	3	4	5	6	7	8
Water	turbid	clear	clear	clear	clear	clear
Maximum width	3.5 m.	1.1 m.	3.0 m.	3.0 m.	1.5 m.	1.0 m.
Maximum depth	1.1 m.	25 cm.	60 cm.	88 cm.	75 cm.	56 cm.
Method of capture	rotenone	rotenone	rotenone	rotenone	rotenone	rotenone
Bottom	silt	silt	silt-rock	sand-rock	sand-rock	gravel-rock
Species						
Strata	No. %	No. %	No. %	No. %	No. %	No. %
Surface (I)	3 *19*	2 *20*	1 *05*	1 *06*	1 *04*	1 *09*
5–30 cm. (II)	0	1 *10*	2 *09*	1 *06*	2 *09*	1 *09*
Mid-water (III)	4 *25*	1 *10*	5 *23*	3 *16*	3 *13*	1 *09*
Lower 30 cm. (IV)	2 *13*	1 *10*	4 *18*	3 *16*	4 *17*	2 *18*
On or in bottom (V)	4 *25*	3 *30*	6 *27*	9 *50*	10 *43*	5 *45*
Indeterminate	3 *19*	2 *20*	4 *18*	1 *06*	3 *13*	1 *09*
Total	16	10	22	18	23	11
Individuals						
Surface (I)	94 *43.7*	2 *03.6*	46 *12.2*	3 *01.4*	95 *18.0*	16 *32.0*
5–30 cm. (II)	0	6 *10.9*	41 *10.9*	16 *07.6*	35 *06.6*	6 *12.0*
Mid-water (III)	51 *23.7*	13 *23.6*	95 *25.3*	16 *07.6*	51 *09.7*	5 *10.0*
Lower 30 cm. (IV)	50 *23.3*	1 *01.8*	123 *32.7*	49 *23.3*	138 *26.2*	4 *08.0*
On or in bottom (V)	11 *05.1*	30 *54.5*	57 *15.2*	124 *59.0*	185 *35.1*	18 *36.0*
Indeterminate	9 *04.2*	3 *05.5*	14 *03.7*	2 *01.0*	23 *04.4*	1 *02.0*
Total	215	55	376	210	527	50

TABLE 20 (*continued*).—Stratification of Fish Communities in Streams of Various Characters in Eastern North Borneo

	Kalabakan		Kretam Kechil			
	Sungei Tawan		Unnamed	Sungei Gaja		
Station	11	12	2	3	4	5
Water	clear	clear	clear	clear	clear	clear
Maximum width	5.0 m.	3.0 m.	3.0 m.	10 m.	1.5 m.	1.0 m.
Maximum depth	1.5 m.	1.7 m.	60 cm.	1.3 m.	60 cm.	60 cm.
Method of capture	rotenone	rotenone	rotenone	rotenone	rotenone	seine
Bottom	silt-rock	silt-rock	silt-gravel	sand-rock	sand-rock	gravel-rock

Species

Strata	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Surface (I)	1	*04*	2	*07*	1	*06*	1	*11*	1	*13*	1	*20*
5–30 cm. (II)	2	*08*	3	*11*	1	*06*	1	*11*	1	*13*	1	*20*
Mid-water (III)	5	*21*	4	*14*	1	*06*	1	*11*	1	*13*	1	*20*
Lower 30 cm. (IV)	2	*08*	2	*07*	0		2	*22*	2	*25*	0	
On or in bottom (V)	6	*25*	9	*32*	2	*11*	1	*11*	1	*13*	0	
Indeterminate	8	*33*	8	*29*	13	*72*	3	*33*	2	*25*	2	*40*
Total	24		28		18		9		8		5	

Individuals

Surface (I)	430	*55.4*	1016	*73.3*	27	*06.3*	269	*45.6*	113	*41.9*	10	*40.0*
5–30 cm. (II)	24	*03.1*	46	*03.3*	40	*09.3*	110	*18.6*	61	*22.6*	1	*04.0*
Mid-water (III)	106	*13.7*	93	*06.7*	9	*02.1*	6	*01.0*	23	*08.5*	4	*16.0*
Lower 30 cm. (IV)	46	*05.9*	74	*05.3*	0		93	*15.8*	27	*10.0*	0	
On or in bottom (V)	48	*06.2*	65	*04.7*	36	*08.4*	31	*05.3*	14	*05.2*	0	
Indeterminate	122	*15.7*	92	*06.6*	316	*73.8*	81	*13.7*	32	*11.9*	10	*40.0*
Total	776		1386		428		590		270		25	

TABLE 20 (*concluded*).—Stratification of Fish Communities in Streams of Various Characters in Eastern North Borneo

	Kretam Kechil Unnamed		Sapagaya		Sepilok		Deramakot Kinabatangan		Deramakot S. Deramakot		Tabalin		Kalabakan S. Marikut	
Station	8		..		..		10		2, 9		..		..	
Water	clear		turbid		turbid		turbid		turbid		turbid		turbid	
Maximum width	2.5 m.		3.0 m.		10 m.		....		10 m.		8.0 m.		10 m.	
Maximum depth	1.0 m.		1.0 m.		1.3 m.		1.3 m.		3.0 m.		2.0 m.		3.0 m.	
Method of capture	rotenone		rotenone		rotenone		seine		rotenone		seine		rotenone	
Bottom	sand-rock		silt-gravel		silt		silt-sand		silt		silt		silt	
							Species							
Strata	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Surface (I)	1	*13*	2	*14*	1	*11*	2	*10*	1	*05*	2	*14*	2	*13*
5–30 cm. (II)	1	*13*	1	*07*	1	*11*	2	*10*	3	*16*	1	*07*	1	*06*
Mid-water (III)	1	*13*	1	*07*	1	*11*	3	*15*	3	*16*	1	*07*	2	*13*
Lower 30 cm. (IV)	0		0		0		4	*20*	4	*21*	5	*36*	1	*06*
On or in bottom (V)	2	*25*	4	*29*	3	*33*	6	*30*	3	*16*	4	*29*	3	*19*
Indeterminate	3	*37*	6	*43*	3	*33*	3	*15*	5	*26*	1	*07*	7	*43*
Total	8		14		9		20		19		14		16	
							Individuals							
Surface (I)	87	*32.6*	34	*16.3*	39	*25.3*	32	*02.7*	2	*01.7*	69	*15.3*	7	*03.3*
5–30 cm. (II)	70	*26.2*	31	*14.9*	34	*22.1*	413	*35.3*	11	*09.2*	231	*51.1*	21	*10.2*
Mid-water (III)	74	*27.7*	35	*16.8*	32	*20.8*	82	*07.0*	48	*40.3*	44	*09.7*	62	*30.0*
Lower 30 cm. (IV)	0		0		0		392	*33.5*	29	*24.4*	64	*14.2*	30	*14.6*
On or in bottom (V)	15	*05.6*	20	*09.6*	34	*22.1*	181	*15.5*	7	*05.9*	43	*09.5*	8	*03.9*
Indeterminate	21	*07.8*	88	*42.3*	15	*09.7*	71	*06.1*	22	*18.5*	1	*00.2*	78	*37.9*
Total	267		208		154		1171		119		452		206	

TABLE 21.—Change in Frequency of Fishes Occupying Various Strata in Different Portions of Streams
Stations are arranged from downstream (left) to upstream (right) within streams

	Deramakot						Kretam Kechil		
	Lowland stream		Hill stream				Sungei Gaja		
	Sta. 3	Sta. 4	Sta. 5	Sta. 6	Sta. 7	Sta. 8	Sta. 3	Sta. 4	Sta. 5
Species									
Strata[1]	No. %	No. %	No. %	No. %	No. %	No. %	No. %	No. %	No. %
I and V	7 *44*	5 *50*	7 *32*	10 *56*	11 *47*	6 *54*	2 *22*	2 *26*	1 *20*
II–IV	6 *38*	3 *30*	11 *50*	7 *38*	9 *39*	4 *36*	4 *44*	4 *51*	2 *40*
Specimens (percentages of total catch)									
I and V	*49*	*58*	*27*	*60*	*53*	*68*	*51*	*47*	*40*
II–IV	*47*	*36*	*69*	*39*	*43*	*30*	*35*	*41*	*20*

[1] Designation of strata in Table 20.

The River Community

Our fishing efforts in the largest rivers were not sufficiently effective to yield representative collections. Aside from Deramakot Station 10, sporadic use of cast nets and hook-and-line was made in the Kinabatangan River and even less use was made of these techniques in the Kalabakan River. Some specimens were accumulated over the years by the former Fisheries Department from the Kinabatangan River and its cut-off meanders, from the Labuk River, and from the Segama River. Though not as complete as the samples of small streams, these river samples permit some generalizations about the fauna of the rivers.

Fifty species are recorded from the large rivers (Kalabakan Kinabatangan, Labuk, and Segama) and cut-off meanders of eastern North Borneo (Table 22); 21 (42 per cent) of the 50 have so far not been collected in the small forest streams, though five occur in the mouths of the larger tributaries. Of the species recorded from the Kinabatangan drainage, 16 (42 per cent) of 38 have not been collected in small forest tributaries. The consistency of this proportion suggests that the true proportion of strictly riverine species in the total fauna is near 40 per cent.

As the information on the faunas of the Kalabakan, Labuk, and Segama Rivers is so fragmentary, the following discussion is confined to the fauna of the Kinabatangan River.

The 38 species known from the Kinabatangan River probably represent only a small fraction of the fauna. The diets of the river species (Table 23) are distributed much like those of the species in the Deramakot hill stream. The vertical distribution of the river fishes (Table 23) differs from that of the fishes in the hill stream mainly in the large proportion of species in the two upper layers (I and II) and the smaller proportion in the bottom stratum (V). These differences seem to reflect the methods and opportunities of collection. Cast nets and shallow seines clearly favor the collection of fishes from the upper level at the expense of the bottom inhabitants in deep, turbid rivers, whereas the use of rotenone in shallow, clear streams makes benthic fishes as accessible as the surface species. Deep, turbid water also makes observation of behavior difficult, so that the proportion of species in the indeterminate category is expected to be higher in the river collection than in that from the small stream.

TABLE 22.—Distribution of Species Found in Major Rivers of Eastern North Borneo

	Rivers				
	Kalabakan	Labuk	Segama	Kinabatangan	Small forest streams[1]
Setipinna melanochir				+	0
Chela oxygastroides	+				0
Nematabramis everetti				+	+
Rasbora myersi				+	0
Rasbora sumatrana				+	+
Rasbora hubbsi				+	+
Luciosoma pellegrini				+	+
Leptobarbus hosii				+	0
Leptobarbus melanotaenia			+		+
Cyclocheilichthys repasson	+		+	+	+
Puntius bulu				+	0
Puntius binotatus		+			+
Puntius bramoides	+		+	+	+
Hampala macrolepidota				+	+
Lobocheilus bo			+	+	+
Schismatorhynchus heterorhynchus				+	+
Tylognathus caudimaculatus				+	0
Osteochilus microcephalus		+	+	+	+
Dangila sabana			+	+	0
Garra borneensis				+	+
Epalzeorhynchos kalliurus				+	+
Homaloptera weberi				+	+
Acanthopsis choirorhynchus				+	+
Nemachilus olivaceus				+	+
Wallago maculatus				+	+
Ompok sabanus			+	+	+
Kryptopterus parvanalis		+	+	+	0
Clarias teysmanni		+			+
Prophagorus nieuhofi		+			+
Acrochordonichthys pachyderma				+	0
Acrochordonichthys melanogaster				+	0
Mystus sabanus			+	+	0
Mystus nemurus	+	+		+	+
Mystus baramensis	+				+
Leiocassis robustus				+	0
Pangasius macronema		+			0
Pangasius tubbi			+	+	0
Pangasius nieuwenhuisi				+	0
Arius maculatus				+	0
Arius microcephalus	+				0
Dermogenys pusillus				+	+
Ophiocephalus striatus				+	+
Osphronemus goramy	+		+	+	+
Johnius semiluctuosus	+				0
Eleotris melanosoma		+		+	+
Oxyeleotris urophthalmus		+			+
Oxyeleotris marmorata			+	+	0
Glossogobius giuris		+			+
Chonerhinus modestus				+	0
Tetraodon leiurus	+				0

[1] Excluding lower reaches of large turbid tributaries such as Deramakot Stas. 2 and 9 and the Tabalin station.

TABLE 23.—Frequency Distributions with Respect to Diet and Stratification of Species of Fishes in Kinabatangan River Compared with Those in the Small Deramakot Hill Stream

	Hill stream species[1]		River species	
	No.	%	No.	%
Exogenous				
Plants	4	*14*	4	*11*
Animals	4	*14*	6	*16*
Endogenous				
Plants	6	*21*	6	*16*
Invertebrates[2]				
First order	1	*04*	1	*03*
Second order	4	*14*	3	*08*
Third order	2	*07*	1	*03*
Fishes	2	*07*	2	*05*
Miscellaneous	1	*04*	1	*03*
Indeterminate	4	*14*	14	*37*
Total	28		38	

	Hill stream species		River species	
Strata[3]	No.	%	No.	%
I	1	*04*	3	*08*
II	2	*07*	4	*11*
III	5	*18*	5	*13*
IV	4	*14*	5	*13*
V	11	*39*	7	*18*
?	5	*18*	14	*37*
	—		—	
Total	28		38	

[1] Deramakot stations 5–8.

[2] For explanation see pp. 218 ff.

[3] For explanation see Table 20.

SUMMARY OF COMMUNITY ORGANIZATION IN SMALL STREAMS

Recurrent groups.—Applying the method[1] of Fager (1957) to the collecting data from the Kretam Kechil, Sapagaya, Sepilok, Kalabakan, Deramakot, and Tabalin bases, two recurrent groups appear. The first, consisting of *Nematabramis everetti, Puntius sealei, Rasbora sumatrana, Hampala macrolepidota, Clarias teysmanni,* and *Anguilla borneensis,* occurs as a unit at four of the bases; of these six species only *H. macrolepidota* is absent from the Sepilok base and only *Nematabramis everetti* is present at Tabalin. The species of this recurrent group have the following stratification: surface, *N. everetti;* 5–20 cm., *R. sumatrana;* mid-water, *P. sealei;* bottom, *C. teys-*

[1] Fager (personal communication) has modified his test of affinity to

$$\frac{J}{\sqrt{n_A n_B}} - \frac{1}{2\sqrt{n_B}} \geqq 0.50,$$

where n_A equals number of occurrences of species A; n_B equals number of occurrences of species B; J equals number of joint occurrences of A and B; and $n_A \leqq n_B$.

manni and *A. borneensis;* all levels, *H. macrolepidota.* Their trophic relations are: second order predator (food exogenous), *N. everetti* and *R. sumatrana;* herbivore (food exogenous), *P. sealei;* second order predator (food endogenous), *C. teysmanni;* third order predator (food endogenous), *A. borneensis;* fourth order predator (food endogenous), *H. macrolepidota.* Thus these six species form a subcommunity occupying all strata of small, clear, or turbid forest streams and utilizing all important food sources except endogenous plants. The members of this group account for between 54 and 80 per cent of the individual fishes caught in the coastal drainages (Kalabakan, Sepilok, Sapagaya, and Kretam Kechil) and for 21 per cent of the catch at Deramakot.

The second recurrent group consists of five species: *Cyclocheilichthys repasson, Osteochilus microcephalus, Lobocheilus bo, Nemachilus olivaceus,* and *Mystus nemurus.* They occupy the following strata: mid-water, *C. repasson;* lowest 30–40 cm., *O. microcephalus, L. bo,* and *M. nemurus;* bottom, *N. olivaceus.* Their feeding habits are: second order predator (food endogenous), *N. olivaceus;* herbivores (food endogenous), *L. bo* and *O. microcephalus;* omnivore, *M. nemurus;* second order predator (food probably equally exogenous and endogenous), *C. repasson.*

Besides having a narrower ecological range, the second group has a more limited geographic distribution, occurring as a unit only in the Kinabatangan drainage (both Deramakot and Tabalin bases). Its members formed 32 per cent of the individual fishes caught at Deramakot and 15 per cent of those caught at Tabalin.

In pools about 1–1.5 meters deep in small forest streams of eastern North Borneo, only one species, *Nematabramis everetti,* lives at the surface. One or two species of *Rasbora,* most commonly *sumatrana,* or one of *Rasbora* and one of *Luciosoma* swim restlessly a few centimeters below the surface. These fishes feed primarily on terrestrial insects that fall or jump into the water and, though they usually form less than 30 per cent of the species in a given place, they account for between 25 and 60 per cent of the total number of individuals.

Below these layers, *Puntius sealei, Cyclocheilichthys repasson,* and less commonly *P. bramoides, P. binotatus,* and *C. apogon,* patrol the middle strata, moving upward to the surface for food missed by species of *Nematabramis, Rasbora,* and *Luciosoma* or downward to pick up food from the bottom. The streamlined *Leptobarbus,* which also lives in the middle layers, is more likely to make sudden rushes to the surface after a flower or seed that has just struck the water. As *Cyclocheilichthys* and *Puntius* feed on terrestrial invertebrates and

Puntius and *Leptobarbus* on fragments of terrestrial plants, the inhabitants of the middle zone swell the proportion of individuals directly dependent on exogenous food to 40–75 per cent.

Just above the bottom, species (usually one each) of *Osteochilus, Lobocheilus,* and *Schismatorhynchus* hover, sucking up mouthfuls of detritus from which they extract cryptogamic aquatic plants and small fragments of vascular plants. At the same level, *Mystus nemurus* and, depending on the geographic location, *M. baramensis* move about eating crustaceans, aquatic insects, and occasionally (in the case of *nemurus,* at least) a fish.

In quiet pools one or two species of *Nemachilus* and *Acanthophthalmus* wriggle into accumulations of dead leaves or burrow into the bottom in search of minute invertebrates. The same type of food is sought by *Acanthopsis choirorhynchus* in various types of bottoms. *Clarias teysmanni* stalks its prey on the bottom or swims upward a few centimeters. One or two species of *Mastacembelus* search through silt, sand, and leaves for aquatic insects.

In swifter water *Epalzeorhynchos, Protomyzon,* and *Homaloptera* maintain themselves among the rocks and gravel of the bottom, the first two living on algae and other cryptogamic plants engulfed along with detritus and *Homaloptera* living on benthic invertebrates. One to three species of *Anguilla* wriggle among the rocks, where they catch prawns and crabs, or burrow into the gravelly bottom and eat aquatic insects. The large rocks projecting from the bottom in clear streams provide substrate and grazing grounds for *Gastromyzon borneensis.* Moving about through the whole community is *Hampala macrolepidota,* the principal predator of fishes.

Small coastal streams near the tidal zone usually harbor from 6 to 12 species of eleotrids and gobies whose roles in the economy of these communities is largely unknown. *Eleotris melanosoma* and *Glossogobius giuris* apparently live close to the bottom, where they feed heavily on prawns and small crabs; it is our guess that *Glossogobius* will prove, upon further investigation, to be an important predator of fishes. *Stenogobius gymnopomus,* the only other goby about which we have some information, has much the same niche as *Acanthopsis.*

The larger turbid streams are poorly known, but they seem to have fish assemblages intermediate between those of large rivers and those of the small forest streams. *Nematabramis* is joined at the surface by *Dermogenys pusillus,* which has a diet similar to that of *Nematabramis.* River fishes of the Kinabatangan basin, such as

Rasbora myersi, *Puntius bulu*, and *Dangila sabana*, move into these turbid streams to occupy upper, middle, and lower strata, respectively, and to feed on terrestrial insects, fragments of terrestrial plants, and detrital material.

ZOOGEOGRAPHIC RELATIONS

For purposes of discussion we are considering North Borneo as divided into three major watersheds: (1) *West Coast* (all streams flowing westward into the South China Sea, plus the drainage of Marudu Bay which empties into Balabac Strait); (2) *Labuk-Segama*

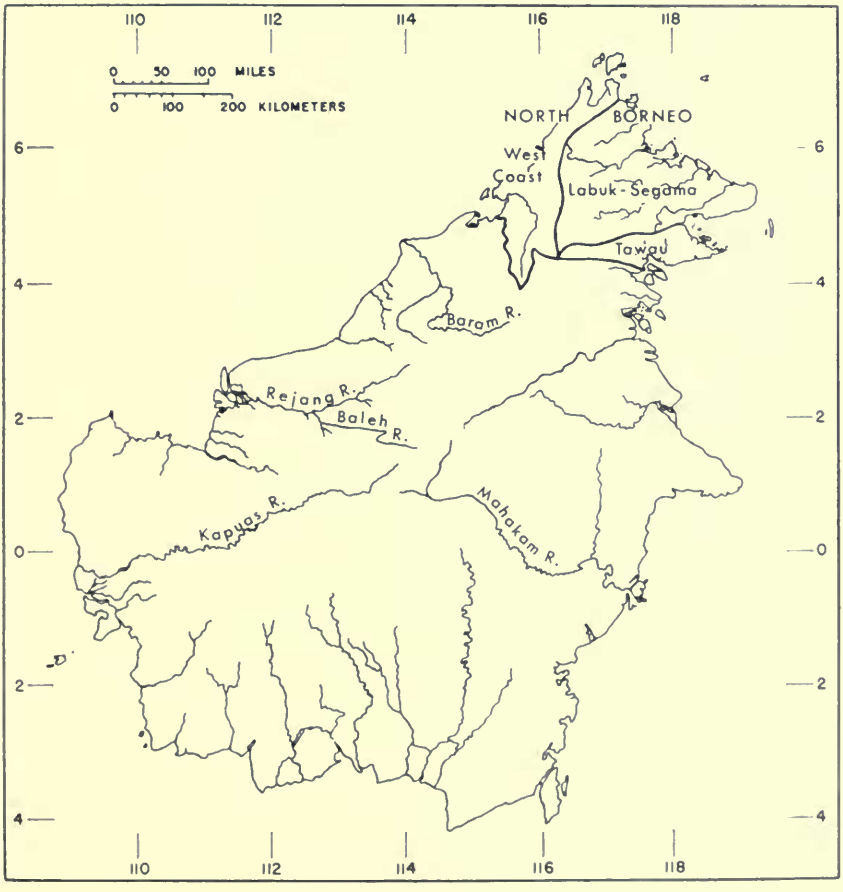

FIG. 113. Watersheds of North Borneo.

(all streams draining into the Sulu Sea); and (3) *Tawau* (all streams flowing into the Celebes Sea) (fig. 113).

We shall refer often to the Baram, Kapuas, and Mahakam rivers (fig. 113) as their faunas are relatively well known, and the rivers, respectively in northwestern, southwestern, and central eastern Borneo, represent very well the various areas of the island and the varying geologic histories of Bornean drainages.

Knowledge of the fresh-water fishes[1] of North Borneo is still fragmentary. Previously 31 species of Ostariophysi had been recorded from North Borneo. In this report the number is increased to 69 (Table 24). This increase, which does not result from the description of many new forms, is to be expected in the study of a poorly explored fauna. Of the 41 North Bornean Ostariophysi now known only from the Labuk-Segama and Tawau watersheds, 11 occur in the Baram drainage of Sarawak just south of the West Coast watershed (Table 24), indicating that a significant number is still to be reported from the West Coast. Similarly, the absence of *Ophicephalus* from the Tawau watershed is almost certainly an accident of sampling. These obvious inadequacies of the present record preclude firm conclusions on the zoogeographic relations of the North Bornean fishes. Nonetheless, some aspects of these relations seem reasonably well established and others are suggested by present knowledge.

Only 9 species occur in all three North Bornean watersheds. Four—*Hampala macrolepidota, Clarias teysmanni, Mystus nemurus,* and *Osphronemus goramy*—are widely distributed in Borneo and in Sundaland (Malaya, Sumatra, Java, and Borneo) generally. Three others—*Nematabramis everetti, Leptobarbus melanotaenia,* and *Betta unimaculata*—occur in one or two of the Baram, Kapuas, and Mahakam rivers, but are confined to Borneo. The two others—*Nemachilus olivaceus* and *Protomyzon griswoldi*—are known only from North Borneo.

Eleven species are found in the West Coast and Labuk-Segama watersheds but not in the Tawau. Four—*Gastromyzon borneensis, Puntius binotatus, Prophagorus nieuhofi,* and *Ophicephalus melanosoma*—are widely distributed in Borneo, occurring in the Baram, Kapuas, and Mahakam rivers, and therefore to be expected in the Tawau watershed. Four—*Gastromyzon borneensis, Glaniopsis ha-*

[1] This discussion is restricted to the primary fresh-water groups (Myers, 1949): Ostariophysi (excluding the marine or brackish catfishes, Plotosidae and Ariidae), Anabantoidea, Ophicephaloidea, and Opisthomi.

TABLE 24.—Distribution of Primary Fresh-Water Fishes of North Borneo

	North Borneo[1]			Sarawak	Indonesian Borneo		Endemic to Borneo	Endemic to North Borneo
	Tawau	Labuk-Segama	West Coast	Baram	Mahakam	Kapuas		
Ostariophysi:								
Chela oxygastroides	+				+	+		
Nematabramis everetti	+	+	+	+			+	
Nematabramis alestes borneensis			+					
Rasbora argyrotaenia			+	+	+	+		
Rasbora einthoveni		+		+		+		
Rasbora hubbsi	+	+					+	+
Rasbora myersi		+				+		
Rasbora rutteni	+				+		+	
Rasbora semilineata		+						
Rasbora sumatrana	+	+		+		+		
Rasbora elegans	+							
Luciosoma pellegrini		+			+		+	
Leptobarbus hosii		+	+	+			+	
Leptobarbus melanotaenia	+	+	+		+	+	+	
Hampala macrolepidota	+	+	+	+	+	+		
Tor douronensis			+	+	+	+		
Cyclocheilichthys apogon	+	+		+		+		
Cyclocheilichthys repasson	+	+		+	+	+		
Puntius binotatus		+	+	+	+	+		
Puntius bramoides	+	+		+	+			
Puntius bulu		+		+	+	+		

[1] Definition of watersheds in text (p. 237).

TABLE 24 (*continued*).—Distribution of Primary Fresh-Water Fishes of North Borneo

	North Borneo			Sarawak	Indonesian Borneo			
	Tawau	Labuk-Segama	West Coast	Baram	Mahakam	Kapuas	Endemic to Borneo	Endemic to North Borneo
Ostariophysi:								
Puntius collingwoodi			+	+	+	+	+	
Puntius orphoides		+				+		
Puntius sealei	+	+					+	+
Puntius strigatus			+				+	+
Dangila sabana		+					+	+
Osteochilus vittatus			+	+	+	+		
Osteochilus microcephalus		+		+	+	+		
Osteochilus spilurus	+	+						
Lobocheilus bo		+	+		+			
Tylognathus caudimaculatus		+						
Schismatorhynchus heterorhynchus		+				+		
Garra borneensis		+	+	+	+		+	
Paracrossochilus acerus			+	+			+	
Epalzeorhynchos kalliurus		+						
Gastromyzon borneensis		+	+	+	+	+	+	
Glaniopsis hanitschi		+	+				+	
Parhomaloptera microstoma		+		+	+		+	
Protomyzon griswoldi	+	+	+				+	+
Protomyzon borneensis		+	+				+	+
Protomyzon whiteheadi		+	+				+	+
Protomyzon aphelocheilus			+				+	+

TABLE 24 (*continued*). Distribution of Primary Fresh-Water Fishes of North Borneo

	North Borneo			Sarawak	Indonesian Borneo			
	Tawau	Labuk-Segama	West Coast	Baram	Mahakam	Kapuas	Endemic to Borneo	Endemic to North Borneo
Ostariophysi:								
Homaloptera weberi		+		+			+	
Acanthophthalmus sandakanensis		+					+	+
Acanthophthalmus mariae		+					+	+
Acanthophthalmus anguillaris	+					+		
Acanthopsis choirorhynchus		+			+	+		
Nemachilus selangoricus	+							
Nemachilus olivaceus	+	+	+				+	+
Wallago maculatus		+					+	+
Ompok sabanus	+	+					+	+
Kryptopterus parvanalis		+		+			+	
Clarias teysmanni	+	+	+	+		+		
Prophagorus cataractus		+						
Prophagorus nieuhofi		+	+	+	+	+		
Glyptothorax major			+	+	+	+		
Mystus baramensis	+	+		+		+	+	
Mystus sabanus		+					+	+
Mystus nemurus	+	+	+	+	+	+		
Mystus planiceps			+		+	+		
Leiocassis robustus		+					+	+
Leiocassis merabensis			+				+	+
Leiocassis micropogon	+					+		

TABLE 24 (*concluded*).—Distribution of Primary Fresh-Water Fishes of North Borneo

	North Borneo			Sarawak	Indonesian Borneo			
	Tawau	Labuk-Segama	West Coast	Baram	Mahakam	Kapuas	Endemic to Borneo	Endemic to North Borneo
Ostariophysi:								
Leiocassis poecilopterus			+			+		
Pangasius macronema		+						
Pangasius nieuwenhuisi		+			+		+	
Pangasius tubbi		+					+	+
Acrochordonichthys melanogaster		+			+	+		
Acrochordonichthys pachyderma		+			+			
Anabantoidea:								
Anabas testudineus		+	+	+		+		
Betta balunga	+						+	+
Betta unimaculata	+	+	+		+		+	
Osphronemus goramy	+	+	+	+	+	+		
Trichogaster trichopterus			+		+	+		
Ophicephaloidea:								
Ophicephalus melanosoma		+	+	+	+	+		
Ophicephalus striatus		+				+		
Opisthomi:								
Mastacembelus keithi		+						+
Mastacembelus maculatus			+			+		
Mastacembelus armatus	+	+		+				

nitschi, *Leptobarbus hosii*, and *Garra borneensis*—are confined to Borneo. Two—*Protomyzon borneensis* and *P. whiteheadi*—are known only from North Borneo.

Ten species are found in the Labuk-Segama and Tawau watersheds but not in the West Coast. Six of them occur in the Baram basin and are likely to be collected in the Padas River of the West Coast watershed. One of these (*Cyclocheilichthys repasson*) occurs in the Kapuas and Mahakam rivers as well as in the Baram. Three of the ten species—*Rasbora hubbsi*, *Puntius sealei*, and *Ompok sabanus*—are known only from North Borneo; probably these fishes will not be found in the West Coast system, though they may be collected in some of the short rivers just south of the Tawau watershed in northeastern Indonesian Borneo. One additional species, *Mystus baramensis*, is a Borneo endemic.

All species occurring in both the Tawau and West Coast watersheds are also found in the Labuk-Segama watershed. Although intensive collecting in the southern headwaters of the Padas River may uncover exceptions to the preceding statement, the effects on the zoogeographic relations outlined here probably will not be great.

TABLE 25.—Proportional Frequency Distribution[1] of Species of Primary Fresh-Water Fishes in Three Watersheds of North Borneo
(Bold-face numbers indicate proportion restricted to one watershed.)

	Proportional Distribution			
	West Coast	Labuk-Segama	Tawau	Total species
West Coast species	**0.41**	0.58	0.26	34
Labuk-Segama species	0.35	**0.48**	0.33	58
Tawau species	0.35	0.73	**0.27**	26

[1] Total proportions in rows exceed 1.00 because some species fall in two columns.

The fauna of the Labuk-Segama watershed shows equal relations to the Tawau and West Coast faunas (Table 25). The last two, however, are each more similar to the Labuk-Segama fauna than to one another.

The experience of collecting and using identical techniques in superficially identical habitats creates an impression of the similarities and differences of faunas as valid as that following statistical analysis in the laboratory. Every cast net thrown in the Kinabatangan River caught *Ompok sabanus*, *Kryptopterus parvanalis*, *Pun-*

tius bramoides, and usually *Rasbora hubbsi. Pangasius tubbi* and *Cyclocheilichthys repasson* were caught frequently and other species (e.g., *Puntius bulu* and *Mystus sabanus*) less often. In the Kalabakan River of the Tawau watershed, the same technique produced no species of *Ompok, Kryptopterus,* or *Pangasius.* Instead, *Puntius bramoides* and *Chela oxygastroides* (a species of a genus not found at all in the Labuk-Segama watershed) were the most common species captured this way. These differences cannot be described simply as accidents of sampling. *Ompok sabanus, Kryptopterus parvanalis,* and *Pangasius tubbi* were collected generally in the Labuk-Segama watershed (pp. 130, 148) and evidently are common in every large river in that watershed.

Every small stream in the Tawau and Labuk-Segama watershed has large populations of *Nematabramis everetti* (see pp. 195 ff.), which is easily caught with rotenone. It is much less generally distributed in the West Coast watershed and is less abundant in the Baram drainage of northern Sarawak (fig. 114). It is apparently absent in central Sarawak, where we fished small tributaries of the Rejang River with the techniques used in superficially identical streams in North Borneo. *Puntius sealei,* as widely distributed (fig. 114) and almost as abundant as *Nematabramis everetti* in the Tawau and Labuk-Segama watersheds, does not occur outside these watersheds.

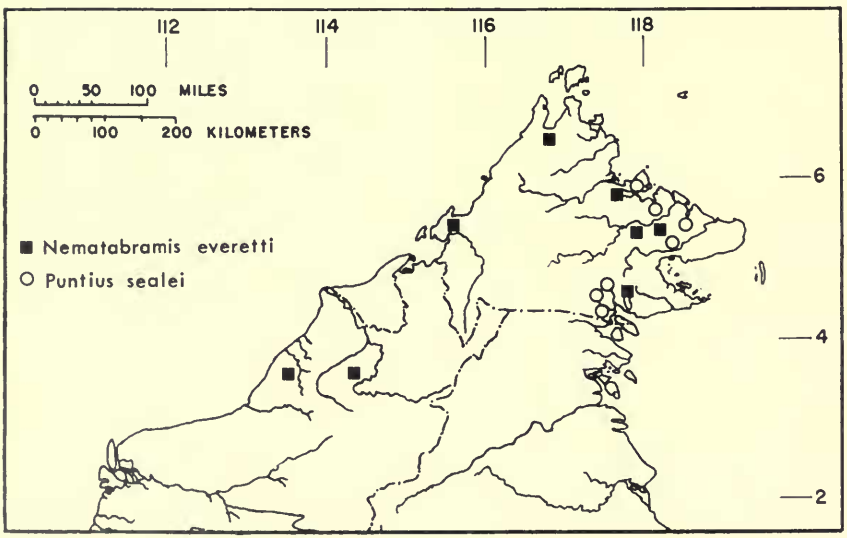

FIG. 114. Distributions of *Nematabramis everetti* and *Puntius sealei.*

Thus, with the throw of a cast net in a large turbid river or with the haul of a seine in a small stream, one's geographic position (at the level of watersheds) can be determined simply by identifying the fishes caught.

TABLE 26.—Distribution of Species of North Bornean Primary Fresh-Water Fishes in Major Bornean Drainages

		Species also Found in Other Drainages					
	Total	Baram		Kapuas		Mahakam	
North Borneo	species	No.	%	No.	%	No.	%
West Coast	34	17	*50*	19	*56*	18	*53*
Labuk-Segama	58	24	*41*	23	*40*	22	*38*
Tawau	26	11	*42*	11	*42*	9	*35*

Most of the North Bornean species are found in other parts of Borneo. About two-thirds (50 species) occur in one or more of the rivers Baram, Kapuas, and Mahakam. The North Bornean forms are distributed almost equally in these three major rivers (Table 26).

One of the peculiarities of the Bornean fauna is the presence of seven fishes known otherwise only from Thailand.[1] Six occur in North Borneo. Three of them, *Tylognathus caudimaculatus, Epalzeorhynchos kalliurus,* and *Prophagorus cataractus,* have been found so far only in the Labuk-Segama watershed of North Borneo. Another species, *Lobocheilus bo,* has been collected in both the Labuk-Segama and West Coast watersheds and in the Mahakam drainage. A fifth, *Glyptothorax major,* occurs in the West Coast system and in the Baram, Mahakam, and Kapuas rivers. A sixth, *Acanthophthalmus anguillaris,* has been collected in the Tawau watershed and in the Kapuas River. The seventh, *Acanthopsis gracilentus* (Smith), was collected by us in the Baleh River basin in central Sarawak.

One of the conspicuous features of the North Bornean fishes is the large gastromyzontid fauna. Four genera (*Gastromyzon, Glaniopsis, Parhomaloptera,* and *Protomyzon*) and seven species are currently known from North Borneo; all of them are endemic to Borneo and four of the species have been recorded only from North Borneo (Table 24). All four genera and six of the species live in the streams draining Mount Kina Balu. De Beaufort (1951) suggests that the presence of these fishes argues for a direct, mountainous land connection between Borneo and China, the other area in which the gastromyzontids have speciated. This hypothesis, which does not take into account the geologic history and structure of the Indo-

[1] Data on Thai distributions taken from Smith (1945).

Malayan region, has been disposed of by Silas (1953), who shows that the Bornean and Chinese groups represent independent, parallel evolution. Another factor, unknown to de Beaufort, is that many of the Bornean gastromyzontids live in swift water at low elevations, i.e., within 200 meters of sea level, so that regardless of the dispersal route between southern China and Borneo, it need not have had high elevations.

Endemism generally is characteristic of the North Bornean fish fauna. The 79 primary fresh-water fishes include 35 (44 per cent) species endemic to Borneo, 19 (24 per cent) of them apparently restricted to North Borneo (Table 24). The proportions of Bornean endemics are roughly equal in the three North Bornean watersheds (Table 27), slightly higher than in the Mahakam drainage, and much higher than in the Kapuas or Baram basins.[1]

With additional collecting the proportions of endemics may change, but the endemism of the North Bornean drainages should always remain high for the absolute numbers of endemics in North Borneo are high compared to those of the Kapuas and Baram.

The list of fishes (Table 24) currently known only from North Borneo includes just 4 swift-water species (all of the genus *Protomyzon*). The habitats of 3 other North Bornean species (*Leiocassis merabensis, Puntius strigatus,* and *Betta balunga*) are unknown, but one may assume that, like their congeners, they live in slowly moving water. The remaining 12 endemics live in slow to moderate currents in the lowlands of eastern North Borneo.

The four species of *Protomyzon* may be widely distributed in the hill streams draining the Crocker Range, which, except for a short gap, is continuous with the mountains forming the boundary between Sarawak and Indonesian Borneo. These are not the type of fishes usually picked up by the non-specialist from natives; gastromyzontids are not caught with cast nets or traps. Consequently one cannot state with assurance that the four species of *Protomyzon* are actually confined to North Borneo.[2]

Several other endemics, for example, *Puntius sealei* (fig. 114) and *Rasbora hubbsi,* may occur in a few streams immediately to the south

[1] The faunas of the Mahakam and Kapuas were compiled from Molengraaff and Weber (1921), Hardenberg (1936), and Weber and de Beaufort (1922). The fauna of the Baram was compiled from Fowler (1905) and Weber and de Beaufort (1913, 1916, 1922). Both lists were modified by information in the recent revisions of Brittan (1954) and Sufi (1956) and by collections available to us.

[2] Silas (1953) reports the genus confined to North Borneo, but in 1956 we collected an undescribed species in central Sarawak.

of the Tawau watershed in northeastern Indonesian Borneo. On the other hand, certain of the lowland endemics probably are confined to North Borneo. Species such as *Wallago maculatus*, *Ompok sabanus*, *Pangasius tubbi*, *Leiocassis robustus*, *Mystus sabanus*, and *Dangila sabana* are susceptible to economic fishing techniques (cast net, hook-and-line, and traps) and, considering their general distribution in the Labuk-Segama watershed, should have been reported from other areas if their ranges were in fact more extensive than present knowledge indicates. *Acanthophthalmus mariae* and *A. sandakanensis* seem to be restricted to small but different areas within the Labuk-Segama watershed. These two species plus *Mastacembelus keithi*, which is more widely distributed within the Labuk-Segama watershed, should have been caught in the Tawau watershed, where the same technique (rotenone) that caught them elsewhere was used in similar habitats.

The eleven species listed in the preceding paragraph probably are restricted to the northeastern corner of Borneo. Whether they are autochthonous in that small area or were formerly more widely distributed in Borneo and have retreated in the face of better adapted species cannot be determined on the basis of current information.

The pattern of Table 27 is in surprising agreement with expectation, considering the Pleistocene history of the Indo-Malayan region.

TABLE 27.—Frequency of Endemics among Primary Fresh-Water Fishes of Various Drainages of Borneo

	Total species	Endemic to Borneo		Endemic to one watershed	
		No.	%	No.	%
North Borneo[1]					
West Coast	34	16	*47*	3	*09*
Labuk-Segama	58	28	*48*	8	*14*
Tawau	26	11	*42*	1	*04*
Mahakam River	85	27	*32*	8	*09*
Kapuas River	151	19	*13*	9	*07*
Baram River	72	9	*13*	3	*04*

[1] Definition of North Bornean watersheds in text (p. 237).

As a result of the lowering of the sea during glaciation (fig. 115), the Kapuas was part of the great North Sunda River at least once during the Pleistocene (Molengraaff and Weber, 1921; Umbgrove, 1938). At that time (or times) the fresh-water faunas of southwestern Borneo, eastern Sumatra, and the Malay Peninsula were essentially one. Possibly the Baram participated in this faunal mixing; but this point

is uncertain. However, it is clear that neither the Mahakam nor the basins of North Borneo had access to this Sundaland fauna except through the limited potentialities of stream piracy at the heads of the watersheds. Thus the differences in the duration of isolation

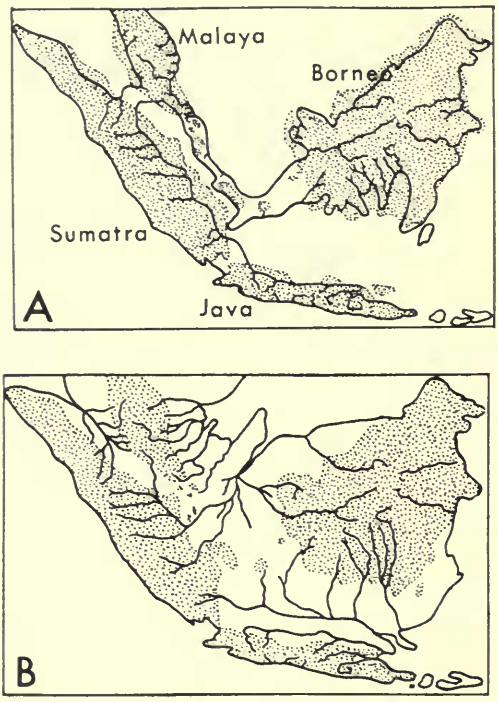

FIG. 115. Pleistocene relations of land areas of Sundaland (after Smit-Sibinga *in* de Beaufort, 1951). Present land masses stippled. Pleistocene coast lines and inland drainages indicated by solid lines. A, First interglacial period. B, Last glacial period.

from the faunas of Sumatra and the Malay Peninsula would lead, all other things being equal, to a higher percentage of endemism in the faunas of the Mahakam and North Borneo than in those of the Kapuas and Baram. The Mahakam, because its sources interdigitate with those of the Kapuas and Rejang (fig. 113), has probably had better opportunities for faunal mixing with the common Sundaland fauna through the agency of stream piracy than have the basins of eastern North Borneo.

Several lines of evidence point to the Labuk-Segama as the most isolated among the three North Bornean watersheds. As the num-

ber of primary fresh-water fishes (genera as well as species) diminishes along the axis Kapuas River—Baram River—North Borneo—Philippine Islands (cf. Weber *in* Molengraaff and Weber, 1921; Fowler, 1905; and Darlington, 1957, p. 51), one must assume that the Kapuas River is closest to the source of the major Sundaland fauna and closest to the center of dispersal. Geographically, the Labuk-Segama watershed is farthest away from this source. Fishes have probably dispersed northeastward to the Rejang, the Baram, and thence to the Padas River and the entire West Coast watershed, or eastward and northward to the Mahakam, the Kajan, and the Tawau watershed. The Labuk-Segama watershed would be the last place reached by fishes using either of these routes, as the West Coast and Tawau watersheds meet south of the Labuk-Segama. The significantly higher proportion of widely distributed species in the West Coast watershed (Table 26) increases the likelihood that fishes have dispersed directly into it rather than into the Labuk-Segama watershed and then into the West Coast watershed.

As a concentration of relicts is an indication of great isolation, the fact that the Labuk-Segama watershed has more (4) Thailand-Borneo relicts than any other Bornean system (p. 245) is evidence that the Labuk-Segama has been isolated longest. The final piece of evidence comes from the proportion of species endemic to one watershed (Table 27), a proportion in which the Labuk-Segama system exceeds all others.

FRESH-WATER FISH CULTURE IN NORTH BORNEO

Fish is one of the cheapest sources of protein and is a staple in the diet of the people of North Borneo. Fish produced from the fish ponds taste as good as fish from the sea and are usually sold alive in the markets. The culture of fresh-water fishes has become important in the interior districts since World War II. There were some fifty acres of fish ponds at the end of 1960. Fish ponds are concentrated in the districts of Tenom, Keningau, Tambunan, and Ranau, and are usually constructed near the banks of a stream where water can be easily diverted into the ponds. There are two types of ponds: the breeding and nursery pond (small and shallow) and the stocking pond (large and deep).

Release of fishes in swamps, cut-off meanders, dams, and the drains of rice fields has also been carried out with varying success by the Fisheries Branch of the Department of Agriculture, North Borneo.

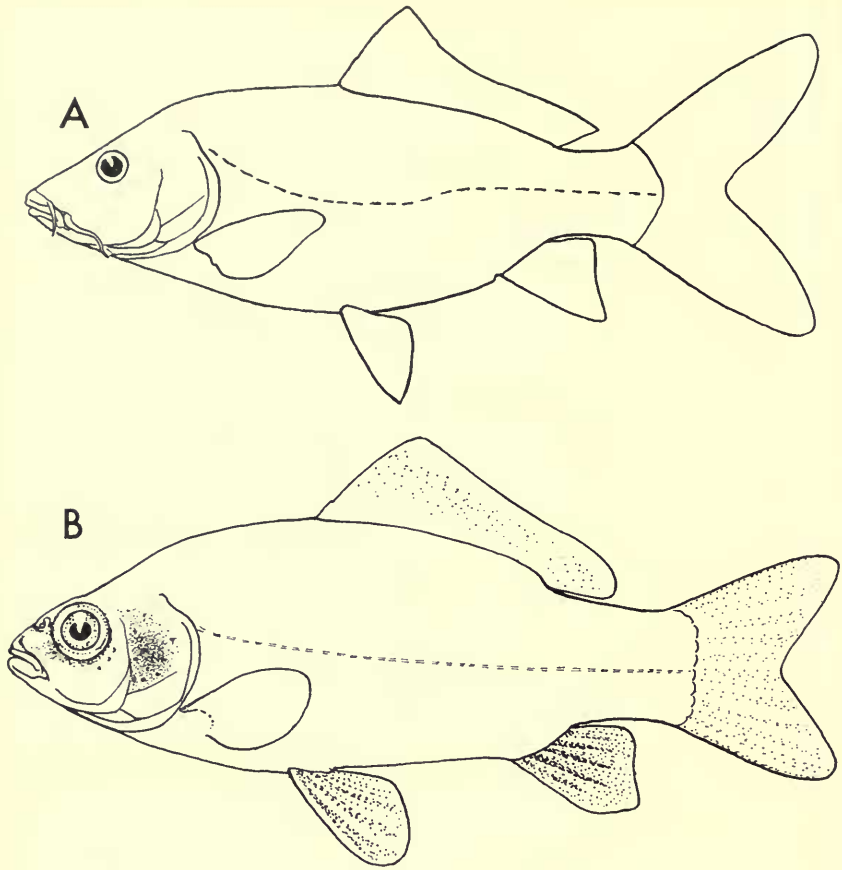

FIG. 116. A, *Cyprinus carpio*. B, *Carassius auratus*.

The following species are used in fish culture in North Borneo:

Cyprinidae:

Common carp (*Cyprinus carpio*) (fig. 116, A)
Goldfish (*Carassius auratus*) (fig. 116, B)
Grass carp (*Ctenopharyngodon idellus*) (fig. 117, A)
Silver carp (*Hypophthalmichthys molitrix*) (fig. 117, B)
Big head (*Aristichthys nobilis*) (fig. 117, C)

Anabantidae:

"Kissing gorami" or "ikan biawan" (*Helostoma temmincki*) (fig. 118)
"Sepat siam" (*Trichogaster pectoralis*) (fig. 119, A)
"Kului" or "gorami" (*Osphronemus goramy*) (fig. 119, B)

Cichlidae:

"Tilapia" or "ikan nile" (*Tilapia mossambica*) (fig. 120)

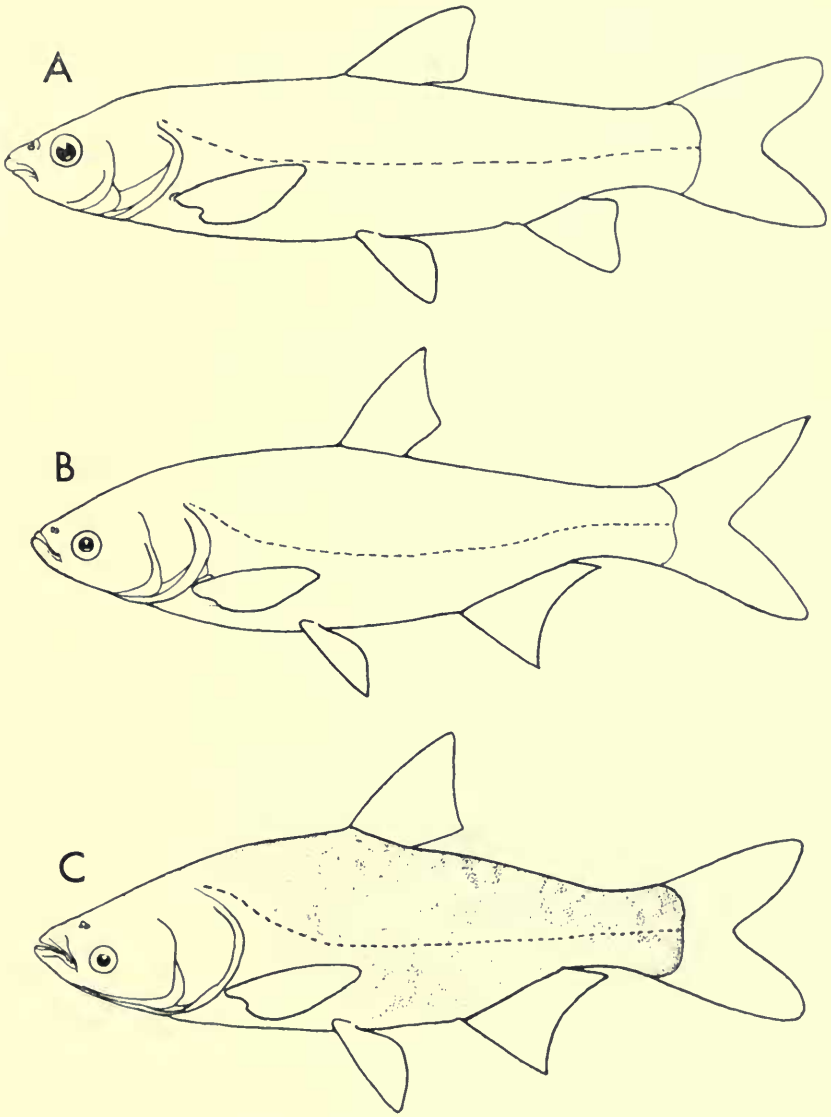

FIG. 117. A, *Ctenopharyngodon idellus*. B, *Hypophthalmichthys molitrix*. C, *Aristichthys nobilis*.

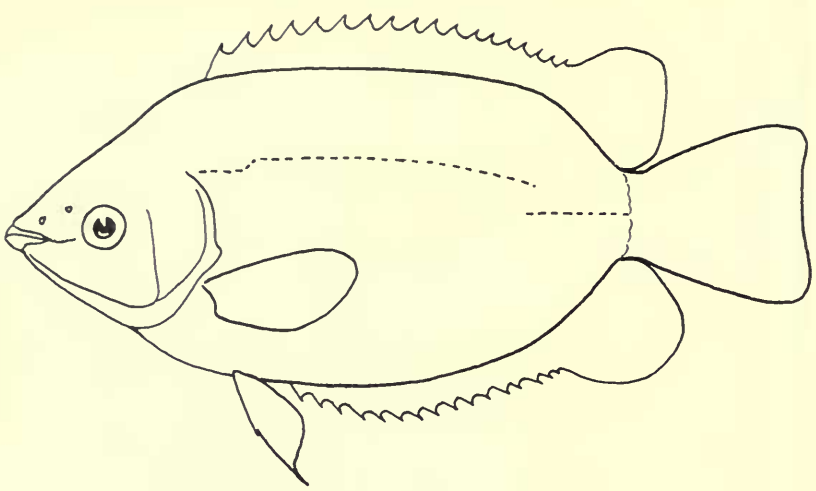

FIG. 118. *Helostoma temmincki.*

These species may be identified by using the following key:

1A. Head scaleless ..... *Cyprinidae* 2.
B. Head covered with scales ..... 6.

2A. Anal spine serrated behind ..... 3.
B. Anal spine not serrated ..... 4.

3A. Four barbels ..... *Cyprinus carpio.*
B. No barbels ..... *Carassius auratus.*

4A. Body cylindrical, scales large, abdomen not keeled ..... *Ctenopharyngodon idellus.*
B. Body compressed, scales small, abdomen completely or partly keeled ..... 5.

5A. Abdomen keeled from isthmus to anus ..... *Hypophthalmichthys molitrix.*
B. Abdomen keeled only between bases of ventral fins and anus. *Aristichthys nobilis.*

6A. Anal fin short, with less than 4 spines ..... *Tilapia mossambica.*
B. Anal fin long, with more than 10 spines ..... 7.

7A. Dorsal fin beginning above bases of pectoral fins ..... *Helostoma temmincki.*
B. Dorsal fin beginning behind bases of pectoral fins ..... 8.

8A. Dorsal fin with 7 spines; 3 soft ventral rays ..... *Trichogaster pectoralis.*
B. Dorsal fin with 12–14 spines; 5 soft ventral rays ..... *Osphronemus goramy.*

Of these nine species only one, "kului" (*Osphronemus*) is indigenous to North Borneo. The common carp was introduced to the country in the early 30's; the "sepat siam" in 1949; the "ikan nile" in 1950; the grass carp, silver carp, and big head, which are also known collectively as Chinese carps, in 1953; the "ikan biawan" in 1956; and the goldfish in 1957.

With the exception of the Chinese carps, which spawn only in their native rivers in the Chinese mainland and recently also in Japan

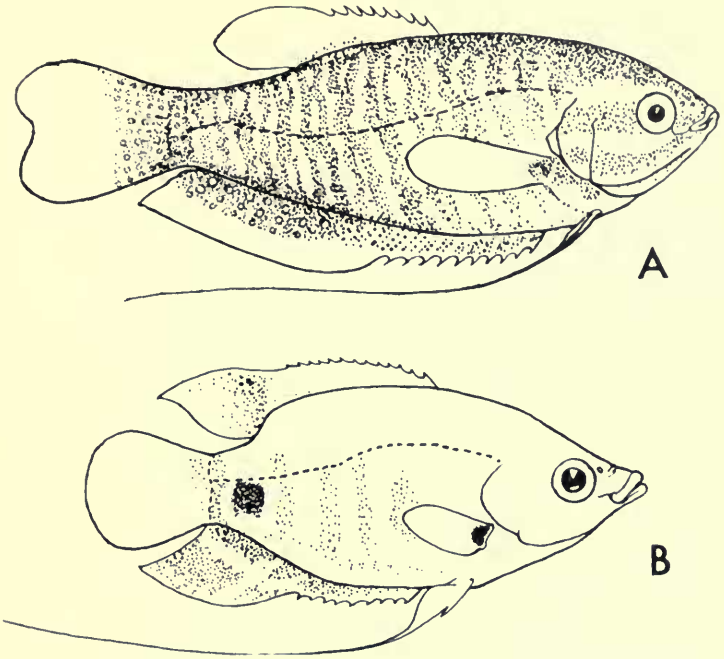

FIG. 119. A, *Trichogaster pectoralis*. B, *Osphronemus goramy*.

(Kuronuma, 1954), the cultivated species spawn in captivity. Fry of the Chinese carps are imported to this country from Singapore or Hong Kong, where fish fry dealers obtain their supply from China (usually between June and October each year).

"Ikan nile" (*Tilapia*) is now the most popular fish for rearing in ponds. A yield of 2,700 lbs. per acre per year (3,000 kg. per hectare per year) in the district of Keningau was achieved in 1960. This high yield is mainly due to the application of the "monosex" culture method.[1]

The traditional Chinese method of pond culture for carps is practiced in this country. Usually four species of carps—common carp (a bottom feeder), grass carp (feeds on grass and weeds), silver carp (feeds on phytoplankton), and big head (feeds on zooplankton)—are reared in a single pond. The advantage of this method is that the feeding habits of these carps are not competitive, resulting in complete utilization of all natural and artificially supplied food materials in the pond.

[1] The use of males only in stocking ponds.

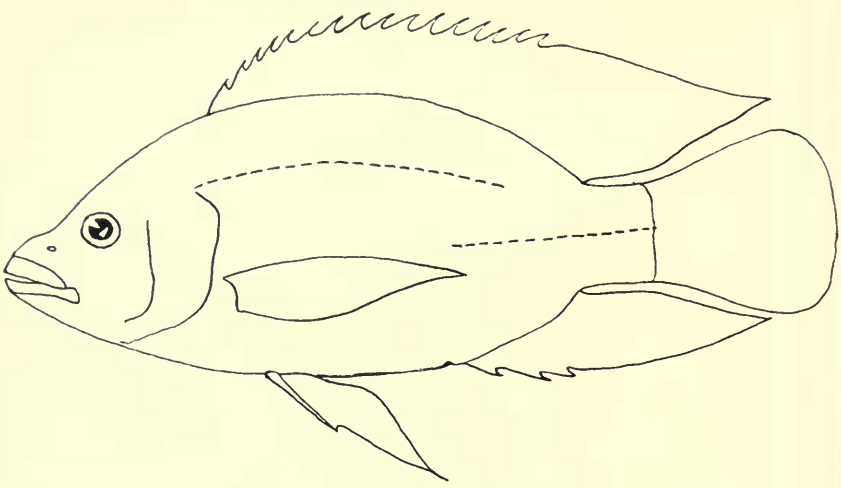

FIG. 120. *Tilapia mossambica.*

"Ikan kului" (*Osphronemus*) is popularly reared in small ponds, preferably those with much vegetation at the edges. "Kului" feeds on leaves, fruits, and insects. It prefers the leaf of taro over other vegetation. "Ikan biawan" (*Helostoma*) prefers the same environment as *Osphronemus*, but it feeds mainly on algae. The goldfish (not the varieties kept in aquaria) prefers ponds with mud bottoms and has the same habits as the common carp. Neither "biawan" nor goldfish are popular in the fish ponds of North Borneo.

The "sepat siam" (*Trichogaster*), chiefly a vegetable feeder, is not suitable for culture in ponds; it is used for rough release. "Ikan nile" (*Tilapia*), apart from pond culture, is also used extensively for rough release.

Technical instructions for building, maintaining, and stocking ponds are offered by the Fisheries Branch, Agriculture Department, Jesselton, North Borneo.

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INDEX TO LOCAL NAMES OF FISHES

A total of 141 species of fishes are described in this book, but only 93 local names have been recorded for them. Many fishes in the rivers bear no name, but some fishes have more than one name. Moreover, local names are often used by a small group of people, and the same name may apply to several fishes of different genera in different places. The word "Ikan" (fish) usually precedes the name in conversation.

Local Name	Dialect[1]	Species
Alangoi	D	*Osteochilus* spp.
Aruan	M	*Ophicephalus* spp.
Badukang	M	*Arius* spp. (small size)
Badung or Batung	M	*Anguilla* spp.
Bakut	D	*Oxyeleotris marmoratus*
Barap	D	*Hampala macrolepidota*
Batduan	D	*Garra borneensis* *Epalzeorhynchus kalliurus*
Batulang	Sg	*Cyclocheilichthys* spp.
Batutu	M	*Oxyeleotris marmoratus*
Baung	M, Sg	*Mystus* spp.
Belanak Sungei	Sg	*Lobocheilus bo*
Belandit	M	*Periophthalmodon* spp.
Belian	D, Sg	*Tor douronensis*
Belut	M	*Monopterus alba*
Biawan	M	*Helostoma temmincki*
Borud	D, Sg	*Protomyzon* spp.
Buntal	M	*Tetraodon* spp.
Buntod	Sg	*Rasbora* spp.
Buntong	D	*Rasbora* spp.
Butul	Sg	*Anguilla* spp.
Duai	Sg	*Puntius* spp. (deep-bodied forms)
Dumpis	D	*Nematabramis everetti*
Gagok	M	*Arius* spp. (medium size)
Gapus	M, Sg	*Ophicephalus* spp.
Garok	D	*Anabas testudineus*
Gepeng	M	*Nematabramis* spp.
Gonsinoi	D	*Rasbora* spp.
Gorami	M	*Osphronemus goramy*

[1] D=Dusun; M=Malay; and Sg=Orang Sungei (people living in the Ulu Kinabatangan).

Local Name	Dialect	Species
Gorap or Garap	D	*Hampala macrolepidota*
Goyuntong	D	*Glyptothorax major*
Hindung	Sg	*Monopterus alba*
Jarau	M	*Johnius semiluctuosus*
Jolong-jolong	M	*Dermogenys pusillus*
Kalauis	D	*Lobocheilus bo*
Karok	D	*Anabas testudineus*
Keli	Sg, M	*Clarias* spp.
Kokok	Sg	*Leiocassis robustus*
Kului or Kalui	M, Sg	*Osphronemus goramy*
Lagai	Sg	*Schismatorhynchus heterorhynchus*
Lais	Sg, M, D	*Kryptopterus parvanalis*
		Ompok sabanus
Lakau	Sg	*Luciosoma pellegrini*
Lallang	M	*Nematabramis everetti*
Lambungau	D	*Leptobarbus* spp.
Lauos	D	*Glaniopsis hanitschi*
Lawang	Sg, M	*Pangasius* spp.
Limpatah	Sg	See Lais (large size)
Lindung	Sg	*Monopterus alba*
Logau	Sg	*Osteochilus* spp. (small size)
Lolau	Sg	*Leptobarbus* spp.
Londoi	D	*Rasbora* spp.
Lontong	Sg	*Puntius bramoides*
Madulang	Sg	*Cyclocheilichthys* spp.
Makalou	Sg	*Leptobarbus* spp.
Mantimus	Sg	*Pangasius* spp.
Manyong	M	*Arius* spp. (large size)
Melugu	Sg	*Glaniopsis hanitschi*
Merah	M	*Lutianus argentimaculatus*
Moh	Sg	*Puntius bulu*
Nile		*Tilapia mossambica*
Orongol	Sg	*Osteochilus* spp.
Pangal	M	*Ophicephalus* spp.
Patin	M	*Pangasius* spp.
Payundong	D	*Glyptothorax major*
Pelaga	M	*Betta* spp.
Putain	M	*Puntius* spp.
Puteh	M	*Osteochilus* spp.
		Puntius sealei
		Puntius bramoides
Puput	M	*Setipinna melanochir*
Rogot	D, Sg	*Gastromyzon borneensis*
Roluo	D, Sg	*Anguilla* spp.
Sakak	Sg	*Ophicephalus* spp.
Salab	D	*Schismatorhynchus heterorhynchus*
Salan	D	*Mastacembelus* spp.

Local Name	Dialect	Species
Selandit	M	*Periophthalmodon* spp.
Selap	D	*Puntius bramoides*
Seluang	M	*Luciosoma* spp.
		Rasbora spp.
Sepat-sepat	D	*Trichogaster trichopterus*
Sepat siam	M	*Trichogaster pectoralis*
Serauyee	D	*Lobocheilus bo*
Sinsilud	D, Sg	*Anguilla* spp.
Sobong	D	*Mystus nemurus*
Songar	D	*Glyptothorax major*
Sumpit-sumpit	M	*Toxotes chatareus*
Tamaing	Sg	*Lutianus argentimaculatus*
Tapah	Sg, M	*Wallago maculatus*
Tigus	Sg	*Puntius* spp.
Tikol	Sg	*Pangasius* spp.
Tilapia		*Tilapia mossambica*
Timpadang-padang	D	*Monopterus alba*
Toros	Sg	*Osteochilus* spp.
Tunjungon	Sg	*Garra borneensis*
		Epalzeorhynchos kalliurus
Turungau	D	*Puntius sealei*
		Puntius binotatus
Ubi	Sg	*Oxyeleotris marmoratus*
Utik	M	*Arius* spp. (small size)

INDEX

Principal taxonomic discussion indicated by **bold-faced** type.